

Support Document 1

Historic “Raffinate” Formula

TABLE I
(ATTACHMENT TO LR-09-A)
PROPERTIES OF RAFFINATE (D-3)

Approximate Composition	Range	Approx. Ave.
Benzene	1-14	3
Toluene	4-40	16
Ethylbenzene	2-16	8
Para Xylene	1-8	6
Meta Xylene	3-23	11
Ortho Xylene	< 1-4	2
Cyclohexane	12-35	20
Methyl Cyclohexane	10-20	12
Other Components (partial list)		
Pentane	Ethyl Cyclohexane	
Cyclopentane	Nonane	
Hexane	Decane	
Methylcyclopentane	Ethyl Benzene	
Heptane	1,4-Dimethyl Benzene	
Octane		
Distillation Range	Range	Approx. Ave.
Start	74-94 °C	84 °C
50%	95-115 °C	103 °C
Dry	139-167 °C	147 °C
Specific Gravity	Range	Approx. Ave.
60/60°F	.785-.840	.815
Flash Points (TCC)	Range	Approx. Ave.
	10	13
	< 10 °F	+25 °F

Reference: Letter from U.S.S. Chemicals, 5/25/77

rr:ja 3-29-78

HB00038

Support Document 2

Bureau Veritas Laboratory Results of Sunoco Raffinate GC-MS

**Results of Analysis****ENVIRONMENTAL PROFILES, INC.**

Bureau Veritas HSE Work Order No. 09051015

Compound Present	Concentration (mg/kg)	Percent Composition (%)
2-methyl pentane	6697	18.8
hexane	4325	12.2
3-methyl pentane	4135	11.6
3-methyl hexane	3065	8.6
2-methyl hexane	2890	8.1
toluene	2645	7.4
benzene	2311	6.5
pentane	2003	5.6
heptane	1520	4.3
2,2-dimethyl butane	1455	4.1
methyl cyclopentane	1388	3.9
2,4-dimethyl pentane	518	1.5
2,2-dimethyl pentane	491	1.4
2-methyl butane	487	1.4
3,3-dimethyl pentane	438	1.2
methyl cyclohexane	219	0.6
2-methyl, 2-pentene	161	0.5
m & p-xylene	171	0.4
2-methyl heptane	116	0.3
3-methyl heptane	80	0.2
ethyl cyclopentane	72	0.2
3-methyl 2-pentene	56	0.2
2,2,4-trimethyl pentane	53	0.1
ethyl benzene	56	0.1
isopropylbenzene	41	0.1
o-xylene	40	0.1
Miscellaneous straight chain, branched, and cyclic hydrocarbons and alkyl benzenes (individually <0.05%)	161	0.5
Total	35596	100.0



**BUREAU
VERITAS**

Results of Analysis

ENVIRONMENTAL PROFILES, INC.

Bureau Veritas HSE Work Order No. 09050605

Compound Present	Concentration (mg/kg)	Percent Composition (%)
2-methyl pentane	5400	18.4
hexane	3600	12.3
3-methyl pentane	3200	10.9
toluene	2600	8.9
3-methyl hexane	2400	8.2
2-methyl hexane	2200	7.5
benzene	1900	6.5
pentane	1700	5.8
heptane	1100	3.8
methyl cyclopentane	1100	3.8
2,2-dimethyl butane	1000	3.4
2-methyl butane	700	2.4
2,4-dimethyl pentane	400	1.4
3,3-dimethyl pentane	400	1.4
2,2-dimethyl pentane	400	1.4
m & p-xylene	130	0.4
2-methyl-2-pentene	120	0.4
1,2-dimethyl cyclopentane	120	0.4
methyl cyclohexane	120	0.4
trans, 1,2-dimethyl cyclopropane	60	0.2
2-methyl heptane	55	0.2
3-methyl heptane	55	0.2
ethyl cyclopentane	50	0.2
3-methyl cyclopentane	45	0.2
ethyl benzene	45	0.2
2,4-dimethyl hexane	40	0.1
3-methyl-2-pentene	40	0.1
2,2,4-trimethyl pentane	40	0.1
isopropylbenzene	30	0.1
o-xylene	30	0.1
2,3-dimethyl hexane	20	0.1
Miscellaneous straight chain, branched, and cyclic hydrocarbons and alkyl benzenes (individually <0.05%)	190	0.6
Total	29300	100

EPI00005

Support Document 3

Bureau Veritas Laboratory Results for Preliminary Liquid Wrench Reformulation GC-MS

**Results of Analysis****ENVIRONMENTAL PROFILES, INC.****Bureau Veritas HSE Work Order No. 09060114**

Compound Present	Concentration (mg/kg)	Percent Composition (%)
cyclohexane	23860	26.2
m & p-xylene	15814	10.5
methyl cyclohexane	9389	10.3
toluene	6819	7.5
ethyl benzene	10963	7.2
benzene	6270	6.9
2-methyl pentane	6106	6.7
hexane	4197	4.6
3-methyl pentane	4007	4.4
o-xylene	5754	3.8
pentane	2373	2.6
heptane	1920	2.1
methyl cyclopentane	1492	1.6
2,2-dimethyl butane	1488	1.6
2-methyl butane	733	0.8
3,3-dimethyl pentane	729	0.8
2,2-dimethyl pentane	643	0.7
2,4-dimethyl pentane	547	0.6
2-methyl, 2-pentene	166	0.2
2-methyl heptane	137	0.2
3-methyl heptane	99	0.1
ethyl cyclopentane	97	0.1
2,2,4-trimethyl pentane	61	0.1
3-methyl 2-pentene	54	0.1
Miscellaneous straight chain, branched, and cyclic hydrocarbons and alkyl benzenes (individually <0.05%)	222	0.4
Total	103941	100.0

Support Document 4

Bureau Veritas Laboratory Results for Preliminary Liquid Wrench Reformulation GC-FID



June 8, 2009

**BUREAU
VERITAS**

Mr. Dale Johnson
ENVIRONMENTAL PROFILES, INC.
8805 Columbia 100 Parkway
Suite 100
Columbia, MD 21045

Subject: Characterization of Solvent Mixture
Bureau Veritas HSE Work Order No. 09060114, Additional

Dear Mr. Johnson:

As discussed, we are pleased to provide our additional analytical laboratory report on the characterization of the solvent sample submitted to us on June 3, 2009. The purpose of the analysis was to provide general breakdown of the material to be used in constructing airborne exposure scenarios under different environmental conditions.

First, the sample was diluted in carbon disulfide and the diluted sample was analyzed by gas chromatography-flame ionization detection (GC-FID). The major components in the samples were quantitated against the specific organic compound. The remaining hydrocarbons present in the sample were quantitated as total hydrocarbons as n-hexane.

All results have been calculated in terms of concentration (wt/wt). The calculations are based upon a specific gravity of 0.777 g/mL of the solvent material received in the laboratory. The table below lists the concentrations of the individual compounds.

Compound	mg/kg
Cyclohexane	198,000
m- & p-Xylene	164,000
Methyl cyclohexane	121,000
Toluene	100,430
Ethyl benzene	93,600
Benzene	42,800
Hexane	46,600
o-Xylene	27,500
Pentane	16,900
Heptane	8,420
Other hydrocarbons	162,000
Total	981,000

It was a pleasure to be of assistance to you on this project. If you have any questions, please contact me at 248.344.2643 or bob.lieckfield@us.bureauveritas.com.

Sincerely,

Robert Lieckfield, Jr., CIH
Division Director, Laboratory Services
Bureau Veritas North America, Inc.

EPI00009

Support Document 5

Bureau Veritas Laboratory Results for Final Liquid Wrench Reformulation GC-FID



June 12, 2009

**BUREAU
VERITAS**

Mr. Dale Johnson
ENVIRONMENTAL PROFILES, INC.
8805 Columbia 100 Parkway
Suite 100
Columbia, MD 21045

Subject: Characterization of Solvent Mixture
Bureau Veritas HSE Work Order No. 09060396

Dear Mr. Johnson:

We are pleased to provide our analytical laboratory report on the characterization of the solvent sample submitted to us on June 10, 2009. The purpose of the analysis was to provide general breakdown of the material to be used in constructing airborne exposure scenarios under different environmental conditions.

First, the sample was diluted in carbon disulfide and the diluted sample was analyzed by gas chromatography-flame ionization detection (GC-FID). The major components in the samples were quantitated against the specific organic compound. The remaining hydrocarbons present in the sample were quantitated as a total hydrocarbons as n-hexane.

All samples have been calculated in terms of mg/kg. The calculations are based off of a specific gravity of 0.753 g/mL of the solvent received in the laboratory. The table below lists the concentrations of the individual compounds.

Compound	mg/kg
Cyclohexane	177,000
m & p Xylenes	149,000
Methyl cyclohexane	109,000
Toluene	87,000
Ethyl benzene	84,000
Benzene	51,000
n-Hexane	40,000
o-Xylene	22,000
Pentane	15,000
Heptane	7,600
Other hydrocarbons	141,000
Total	882,600

It was a pleasure to be of assistance to you on this project. If you have any questions, please contact me at 248.344.2643 or bob.lieckfield@us.bureauveritas.com.

Sincerely,

Robert Lieckfield, Jr., CIH
Division Director, Laboratory Services
Bureau Veritas North America, Inc.

EPI00011

Support Document 6

Historic Liquid Wrench Formulation

APPENDIX NO. 3 TO LR-09A

LIQUID WRENCH NO. 1

PHYSICAL PROPERTIES OF VARIOUS FORMULAS

	LIQUID WRENCH STD. DEOD.		EXPERIMENTAL FORMULAS		
	A	B	C		
Specific Gravity 60/60°F.	0.820	0.830	0.766	0.820	0.785
Density, lb/gal. (calc.)	6.84	6.93	6.39	6.84	6.55
Initial Boiling Point °F.	170	348	237	242	240
Viscosity, Kinem. @100°F.					
Viscosity, Brookfield (approx. cp. @75°F.)	9.0		8.0	13.00	10.0
Evaporation Rate (15' test)	27	9	24	15	11
Flash Point TCC °F.	27		47	48	122
Surface Tension	36	44	28	35	38
Torque Reduction	77	83	75	77	85
% Non-Volatile	10.76	~8.0	9.05	9.29	9.16
Corrosion (Cu Test ASTM D130)	lb.	3a-b	lb	lb	1b
Corrosion (24 hr protection)	Fail	Fail	Fail	Fail	Fail

LIQUID WRENCH NO. 1

PROPERTIES OF VARIOUS FORMULAS

NOTE: Appearance and odor.

All formulas have similar appearance, dark, almost black liquid. The odor is also similar because an odorant is used in all of them. However, Liquid Wrench No. 1 standard, containing Raffinate, has a more characteristic aromatic odor, resembling Methyl-Benzene (Toluene and Xylene). The sample Liquid Wrench No. 1 Deodorized (from last year production) was made with Diesel Fuel No. 2, and had a characteristic, unpleasant odor, typical of the Diesel Fuel.* The odor of Formula C, using V M & P has a clean, pleasant odor.

(*) Liquid Wrench No. 1 Deodorized is presently made with Kerosene.

TT:ja 3-29-78

Support Document 7

James Wells deposition excerpts, Historic Liquid Wrench Oil Additive Document

Depo of James Wells 5/10/1998

LIMON vs. APEX MARINE

Condenselt™

WELLS, JAMES

Page 21

Page 23

1 A. Yes.
 2 Q. Does that inhibitor package exist for a
 3 certain intended use or the protection of the product
 4 itself?
 5 MS. FREEMAN: Mr. Hobson, are you talking
 6 about the time period of '71-'72 or current?
 7 BY MR. HOBSON:
 8 Q. '71-'72.
 9 A. The inhibitors that are in there or
 10 designed by someone, whoever designed the product,
 11 perhaps as far back as 1941, I don't know when it was
 12 designed, but it's to protect the stock, that is the
 13 nuts and bolts, from oxidation.
 14 Q. Would the package that contained regular
 15 Liquid Wrench in 1971 have a different indication
 16 with regard to these inhibitors than the deodorized
 17 Liquid Wrench?
 18 A. I don't understand your question.
 19 Q. If I had -- let's see if we can get a
 20 foundation. Regular Liquid Wrench was sold how?
 21 What kind of packaging?
 22 A. It was sold in various sizes in a metal
 23 can and larger.
 24 Q. We're talking about pints, quarts, that
 25 size?

Page 22

Page 24

1 A. Yes.
 2 Q. What about deodorized Liquid Wrench?
 3 A. It was sold in the aerosol version and 4
 4 ounce.
 5 Q. Did you say and 4 ounce or aerosol 4
 6 ounce?
 7 A. Aerosols and 4 ounce.
 8 Q. So the 4 ounce would be a small liquid
 9 can which would have the drip spout in the top?
 10 A. Correct.
 11 Q. What would be difference for the intended
 12 uses between the aerosol Liquid Wrench and regular
 13 Liquid Wrench, if there was any?
 14 A. The regular was a more of a professional
 15 type product.
 16 Q. So the aerosol 4 ounce was more for
 17 consumers?
 18 A. Yes.
 19 Q. If you look at the deodorized Liquid
 20 Wrench can, 4-ounce can, and you look at the small
 21 can for regular Liquid Wrench, would there be an
 22 indication on the labels that one contained these
 23 inhibitors and one did not?
 24 A. No.
 25 Q. I take it there was a difference in

1 smell?
 2 A. Yes.
 3 Q. Would that be so?
 4 A. Yes.
 5 Q. The odorant that was used deodorized
 6 Liquid Wrench -- wait a minute, maybe I got that
 7 wrong. Which one had the deodorant, the regular
 8 Liquid Wrench or the deodorized?
 9 A. Both.
 10 Q. They just got different odorants?
 11 A. I don't recall whether they were the same
 12 or different.
 13 Q. Let's go back to the document that's
 14 0009, the regular Liquid Wrench, ingredients as of
 15 1972. Is this the formula for regular Liquid Wrench
 16 as of that time period?
 17 A. Yes.
 18 Q. Drip oil. Tell me what you understand
 19 drip oil to have been at that time.
 20 A. Drip oil and rafinate are one in the
 21 same.
 22 Q. All right, sir. And motor oil, can you
 23 tell me how you -- what does motor oil mean in this
 24 context of 0009?
 25 A. Motor oil was simply a lubricant so that

1 when you began to loosen a threaded section, it would
 2 lubricate the movement.
 3 Q. What was your source of motor oil, was it
 4 virgin or was it used?
 5 A. Virgin.
 6 Q. Did you buy regular motor oil like you
 7 put in the crank case of the car or were these the
 8 base stocks for making motor oil?
 9 A. Base stock.
 10 Q. You have oil dag. That's what you
 11 mentioned earlier. Can you tell me what that is?
 12 A. It's a colloidal suspension of graphite.
 13 Q. Does dag have some meaning?
 14 A. I don't know what it means.
 15 Q. Basically, it's graphite suspended in an
 16 oil medium?
 17 A. Correct.
 18 Q. The graphite also is a lubricant?
 19 A. Correct.
 20 Q. And then the perfume, that's deodorant
 21 you added to give the smell you wanted?
 22 A. Correct.
 23 Q. Can you tell me how long this was a
 24 formula for regular Liquid Wrench?
 25 A. I can only tell you from 1972 forward.

REPORT NO. 30DATE 10/28/71

RADIATOR SPECIALTY CO.
CHARLOTTE, N. C.

TESTING LABORATORY REPORT

MATERIAL TESTED Viscosity of Regular Liquid Wrench Ingredients
 $\frac{1}{6}$ 2000 G.M. BATH

	Code	Sp. Gr. @ 60°F	CPS @ 80°F	BY WT	Percent by Volume
DRIP OIL	D-3	0.780	1.5 ² /62	8.5	87.3
MOTOR OIL	M-3	0.910	6	67.0	11.31
21L DAG	O-1	0.980	1980.0	.31	0.25
PERFUME	D-5	0.871	13.5	1.08	0.99
					100.00

density of finish product based on above. .7942 gm/ml

5 gm/l/min. 70 gm/l/min.

FCC

1-08 - 187.86 + 10 \approx 198 Gms

V

1-32 751.5 + 90.5 \approx 761

APPROVED:

RSC 10/28/71

TEST REPORT

**BROOKFIELD ENGINEERING LABORATORIES,
INC.**

TEST INFORMATION
initial

TEST MATERIAL
Regular Sigmatiul Mastic

TEST MATERIAL

四

TEST INFORMATION

VALLE 67

卷之三

1015

FACTOR	VISCOSE CPS.	TEMP. °F.	TIME	NOTES
1	6.5	80°	88.888 1/2 hr 21°C	D-3
1	6.7	80°	9.888 1/2 hr 21°C	H-3
20	1,960	80°	0.25 1/2 hr 21°C	C-1
1	13.5	50°	0.99 1/2 hr 21°C	D-5

RSC 100172

CONCLUSIONS

Support Document 8

Crystal 100 Base Oil Specifications Sheet



Mineral Oil Application Equipment MagPlus Road Dust Control

CRYSTAL 100 Base Oil

6/3/09 Note: Verbal discussion with Mark @ SIE stated Crystal

Crystal 100 Base Oil a process white mineral oil.

Plus TW 100 is the same as Crystal 100 Base Oil

6/3/09 Mark stated specific gravity for this product was 0.863.

Features

- Economical for users who require white oils without the higher cost of food grade oils
- Excellent Lubricity

Applications

- Process oils and extenders for light colored rubber and plastics
- Textile fiber Lubricants
- Process aids for color stable caulks and sealants
- Lubricant for drawing, stamping, forming
- Fiber lubricant for textile fibers/fabric
- Plasticizer for rubber used on conveyor belts; also used in hoses, rollers, etc.
- De-foamer in manufacturing of paper and adhesives

Properties	Test Method	Min	Max	Typical
Viscosity				
@100C cST	D445			4.1
@40 C Cst	D445	18	21	20
@100 F SUS	Calculated			105
Viscosity Index	D2270	100		104
Sulfur %	D2622		0.03	<0.001
Aromatics %	HPLC		3.0	1.8
CCS Vis @ -25, cP	D5239		1800	1300
Brookfield Vis				
@ -40 C, cP	STO328		19000	15000
Color, ASTM	D1500		1.0	0.5
Pour Point C	D5950		-12	-13
Flash COC, C	D0092	185		208
API Gravity	D4052	Report		34.0

Consult the Material Safety Data Sheet (MSDS) for safety and handling information. To obtain an MSDS, call (512) 396-3399 ext 24.

MATERIAL SAFETY DATA SHEET

MSDS No.

CRYSTAL 100 BASE OIL

Rev. Date 4/8/03

STE Oil Company, Inc.
 2001 Clovis Barker
 San Marcos, TX 78666

IMPORTANT: Read this MSDS before handling and disposing of this product and pass this information on to employees, customers, and users of this product.

I. PRODUCT IDENTIFICATION		
Trade Name	CRYSTAL 100 BASE OIL	
Other Names	WHITE MINERAL BASE OIL	
Chemical Family	PETROLEUM HYDROCARBONS	
Generic Name	WHITE MINERAL BASE OIL	
CAS No.	64742-54-7	Company ID No.
		Telephone Numbers
		EMERGENCY 800/424-9300 CHEMREC
		CUSTOMER SERVICE 512/396-3399 MSDS/INFO
DOT Hazardous Materials Proper Shipping Name		
DOT Hazard Class		
UN/NA ID No.	NOT REGULATED	
II. PRODUCT/INGREDIENTS		
CAS#	CONCENTRATION	INGREDIENTS
64742-54-7	100% VOLUME 100% VOLUME	BASE OIL HYDROTREATED HEAVY PARAFFINIC DISTILLATE
III. HAZARDS IDENTIFICATION		
Emergency Overview	APPEARANCE & ODOR: BRIGHT AND CLEAR LIQUID. SLIGHT HYDROCARBON ODOR. HEALTH HAZARDS: NO KNOWN IMMEDIATE HEALTH HAZARDS. MAY BE HARMFUL OR FATAL IF SWALLOWED. DO NOT INDUCE VOMITING. MAY CAUSE ASPIRATION PNEUMONIA. PHYSICAL HAZARDS: NO KNOWN PHYSICAL HAZARDS.	
Inhalation	INHALATION OF VAPORS (GENERATED AT HIGH TEMPERATURES ONLY) OR OIL MIST MAY CAUSE MILD IRRITATION OF THE NOSE, THROAT, AND RESPIRATORY TRACT.	
Eye Irritation	LUBRICATING OILS ARE GENERALLY CONSIDERED NO MORE THAN MINIMALLY IRRITATING TO THE EYES.	
Skin Contact	LUBRICATING OILS ARE GENERALLY CONSIDERED NO MORE THAN MINIMALLY IRRITATING TO THE SKIN. PROLONGED AND REPEATED CONTACT MAY RESULT IN DEFAFFING AND DRYING OF THE SKIN THAT MAY CAUSE VARIOUS SKIN DISORDERS SUCH AS DERMATITIS, FOLLICULITIS OR OIL ACNE.	
Ingestion	THIS MATERIAL MAY BE HARMFUL OR FATAL IF SWALLOWED. INGESTION MAY RESULT IN VOMITING; ASPIRATION (BREATHING) OF VOMITUS INTO LUNGS MUST BE AVOIDED AS EVEN SMALL QUANTITIES MAY RESULT IN ASPIRATION PNEUMONITIS.	
Signs and Symptoms	IRRITATION AS NOTED ABOVE. ASPIRATION PNEUMONITIS MAY BE EVIDENCED BY COUGHING, LABORED BREATHING AND CYANOSIS (BLUISH SKIN); IN SEVERE CASES, DEATH.	
Aggravated Medical Conditions	PRE-EXISTING EYE, SKIN AND RESPIRATORY DISORDERS MAY BE AGGRAVATED BY EXPOSURE TO THIS PRODUCT. FOR ADDITIONAL HEALTH INFORMATION, REFER TO SECTION 11.	

EPI00020

IV.**FIRST AID MEASURES**

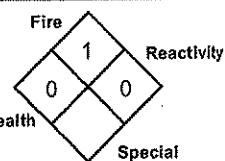
Inhalation	REMOVE VICTIM TO FRESH AIR AND PROVIDE OXYGEN IF BREATHING IS DIFFICULT. GET MEDICAL ATTENTION.
Eye Contact	FLUSH EYES WITH WATER. IF IRRITATION OCCURS, GET MEDICAL ATTENTION.
Skin Contact	REMOVE CONTAMINATED CLOTHING AND SHOES AND WIPE EXCESS FROM SKIN. FLUSH SKIN WITH WATER, THEN WASH WITH SOAP AND WATER. IF IRRITATION OCCURS, GET MEDICAL ATTENTION. DO NOT REUSE CLOTHING UNTIL CLEANED.
Ingestion	DO NOT INDUCE VOMITING. IF VOMITING OCCURS SPONTANEOUSLY, KEEP HEAD BELOW HIPS TO PREVENT ASPIRATION OF LIQUID INTO LUNGS. GET MEDICAL ATTENTION.

V.**FIRE FIGHTING MEASURES**

Flash Point Method	
406° F/207.78° C (Cleveland Open Cup)	
Extinguishing Media	MATERIAL WILL FLOAT AND CAN BE RE-IGNITED ON SURFACE OF WATER. USE WATER FOG, "ALCOHOL FOAM", DRY CHEMICAL OR CARBON DIOXIDE (CO ₂) TO EXTINGUISH FLAMES. DO NOT USE A DIRECT SPRAY OF WATER.
Firefighting Instructions	MATERIAL WILL NOT BURN UNLESS PREHEATED. CLEAR FIRE AREA OF ALL NON-EMERGENCY PERSONNEL. ONLY ENTER CONFINED FIRE SPACE WITH FULL GEAR, INCLUDING A POSITIVE PRESSURE NIOSH-APPROVED, SELF-CONTAINED BREATHING APPARATUS. COOL SURROUNDING EQUIPMENT, FIRE-EXPOSED CONTAINERS AND STRUCTURES WITH WATER. CONTAINER AREAS EXPOSED TO DIRECT FLAME CONTACT SHOULD BE COOLED WITH LARGE QUANTITIES OF WATER (500 GALLONS WATER PER MINUTE FLAME IMPINGEMENT EXPOSURE) TO PREVENT WEAKENING OF CONTAINER STRUCTURE.

HAZARD RATING:

4 = Extreme
3 = High
2 = Moderate
1 = Slight
0 = Insignificant

**VI.****ACCIDENTAL RELEASE MEASURES**

Protective Measures	MAY BURN ALTHOUGH NOT READILY IGNITABLE. WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT WHEN CLEANING UP SPILLS. REFER TO SECTION 8.
Spill Management	FOR SMALL SPILLS: SOAK UP RESIDUE WITH AN ABSORBENT SUCH AS CLAY, SAND OR OTHER SUITABLE MATERIAL. PLACE IN NON-LEAKING CONTAINER AND SEAL TIGHTLY FOR PROPER DISPOSAL. REPORTING: CERCLA: PRODUCT IS COVERED BY EPA'S COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA) PETROLEUM EXCLUSION. RELEASES TO AIR, LAND, OR WATER ARE NOT REPORTABLE UNDER CERCLA (SUPERFUND). CWA: THIS PRODUCT IS AN OIL AS DEFINED UNDER SECTION 311 OF EPA'S CLEAN WATER ACT (CWA). SPILLS INTO OR LEADING TO SURFACE WATERS THAT CAUSE A SHEEN MUST BE REPORTED TO THE NATIONAL RESPONSE CENTER, 1-800-424-8802.

VII.**HANDLING AND STORAGE**

Precautionary Measures	WASH WITH SOAP AND WATER BEFORE EATING, DRINKING, SMOKING, APPLYING COSMETICS, OR USING TOILET. LAUNDER CONTAMINATED CLOTHING BEFORE REUSE. PROPERLY DISPOSE OF CONTAMINATED LEATHER ARTICLES SUCH AS SHOES OR BELTS THAT CANNOT BE DECONTAMINATED. AVOID HEAT, OPEN FLAMES, INCLUDING PILOT LIGHTS, AND STRONG OXIDIZING AGENTS. USE EXPLOSION-PROOF VENTILATION TO PREVENT VAPOR ACCUMULATION. GROUND ALL HANDLING EQUIPMENT TO PREVENT SPARKING.
Storage	STORE IN A COOL, DRY PLACE WITH ADEQUATE VENTILATION. KEEP AWAY FROM OPEN FLAMES AND HIGH TEMPERATURE.
Container Warnings	KEEP CONTAINERS CLOSED WHEN NOT IN USE. CONTAINERS, EVEN THOSE THAT HAVE BEEN EMPTIED, CAN CONTAIN EXPLOSIVE VAPORS. DO NOT CUT, DRILL, GRIND, WELD OR PERFORM SIMILAR OPERATIONS ON OR NEAR CONTAINERS.

MSDS No.

CRYSTAL 100 BASE OIL

Rev. Date 4/8/03

VIII.**EXPOSURE CONTROLS/PERSONAL PROTECTION**

OIL MIST, MINERAL OIL MIST, MINERAL	ACGIH TLV OSHA PEL	TWA: 5mg/m ³ TWA: 5mg/m ³	STEL: 10mg/m ³
Exposure Controls	ADEQUATE VENTILATION TO CONTROL AIRBORNE CONCENTRATIONS BELOW THE EXPOSURE GUIDELINES/LIMITS.		
Personal Protection	PERSONAL PROTECTIVE EQUIPMENT (PPE) SELECTIONS VARY BASED ON POTENTIAL EXPOSURE CONDITIONS SUCH AS HANDLING PRACTICES, CONCENTRATION AND VENTILATION. INFORMATION ON THE SELECTION OF EYE, SKIN AND RESPIRATORY PROTECTION FOR USE WITH THIS MATERIAL IS PROVIDED BELOW.		
Eye Protection	SAFETY GLASSES WITH SIDE SHIELDS.		
Skin Protection	USE PROTECTIVE CLOTHING WHICH IS CHEMICALLY RESISTANT TO THIS MATERIAL. SELECTION OF PROTECTIVE CLOTHING DEPENDS ON POTENTIAL EXPOSURE CONDITIONS AND MAY INCLUDE GLOVES, BOOTS, SUITS AND OTHER ITEMS. THE SELECTION(S) SHOULD TAKE INTO ACCOUNT SUCH FACTORS AS JOB TASK, TYPE OF EXPOSURE AND DURABILITY.		
	PUBLISHED LITERATURE, TEST DATA AND/OR GLOVE AND CLOTHING MANUFACTURERS INDICATE THE BEST PROTECTION IS PROVIDED BY: NEOPRENE OR NITRILE RUBBER.		
Respiratory Protection	IF ENGINEERING CONTROLS DO NOT MAINTAIN AIRBORNE CONCENTRATIONS TO A LEVEL WHICH IS ADEQUATE TO PROTECT WORKER HEALTH, AN APPROVED RESPIRATOR MUST BE WORN. RESPIRATOR SELECTION, USE AND MAINTENANCE SHOULD BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE OSHA RESPIRATORY PROTECTION STANDARD, 29 CFR 1910.134.		
	TYPES OF RESPIRATOR(S) TO BE CONSIDERED IN THE SELECTION PROCESS INCLUDE: FOR MIST: AIR PURIFYING, R OR P STYLE NIOSH APPROVED RESPIRATOR. FOR VAPORS: AIR PURIFYING, R OR P STYLE PREFILTER & ORGANIC CARTRIDGE, NIOSH APPROVED RESPIRATOR. SELF-CONTAINED BREATHING APPARATUS.		

IX.**PHYSICAL AND CHEMICAL DATA**

Flash Point Method 406° F/207.78° C (Cleveland Open Cup)	Specific Gravity (H ₂ O = 1 at 39.2° F) 0.8405	Stability STABLE	Viscosity 18CsT @ 40°C
Appearance and Odor	BRIGHT AND CLEAR LIQUID. SLIGHT HYDROCARBON ODOR.		
Substance and Chemical Family	PETROLEUM HYDROCARBON		
Appearance	BRIGHT AND CLEAR LIQUID		

X.**REACTIVITY AND STABILITY**

Stability	MATERIAL IS STABLE UNDER NORMAL CONDITIONS.
Conditions to Avoid	AVOID HEAT AND OPEN FLAMES.
Materials to Avoid	AVOID CONTACT WITH STRONG OXIDIZING AGENTS.
Hazardous Decomposition Products	THERMAL DECOMPOSITION PRODUCTS ARE HIGHLY DEPENDENT ON COMBUSTION CONDITIONS. A COMPLEX MIXTURE OF AIRBORNE SOLIDS, LIQUIDS AND GASES WILL EVOLVE WHEN THIS MATERIAL UNDERGOES PYROLYSIS OR COMBUSTION. CARBON MONOXIDE AND OTHER UNIDENTIFIED ORGANIC COMPOUNDS MAY BE FORMED UPON COMBUSTION.

XI.**TOXICOLOGICAL INFORMATION**

Acute Toxicity	DERMAL LD ₅₀ >5.0g/kg (RABBIT)	OSHA: NON-TOXIC BASED ON SIMILAR MATERIAL(S)
	ORAL LD ₅₀ >5.0g/kg (RAT)	OSHA: NON-TOXIC BASED ON SIMILAR MATERIAL(S)
Base Oil	NTP: NO	IARC: NO
Sensitization	ACGIH: NO	
	OSHA: NO	
	MATERIAL IS NON-SENSITIZING TO SKIN.	

MSDS No.

XII.**ECOLOGICAL INFORMATION**

Environmental Impact Summary THERE IS NO ECOLOGICAL DATA AVAILABLE FOR THIS PRODUCT. HOWEVER, THIS PRODUCT IS AN OIL. IT IS PERSISTENT AND DOES NOT READILY BIODEGRADE. HOWEVER, IT DOES NOT BIOACCUMULATE.

XIII.**DISPOSAL INFORMATION**

RCRA Information UNDER RCRA, IT IS THE RESPONSIBILITY OF THE USER OF THE MATERIAL TO DETERMINE, AT THE TIME OF THE DISPOSAL, WHETHER THE MATERIAL MEETS RCRA CRITERIA FOR HAZARDOUS WASTE. THIS IS BECAUSE MATERIAL USES, TRANSFORMATIONS, MIXTURES, PROCESSES, ETC., MAY AFFECT THE CLASSIFICATION. REFER TO THE LATEST EPA, STATE AND LOCAL REGULATIONS REGARDING PROPER DISPOSAL.

XIV.**TRANSPORT INFORMATION**

US DEPARTMENT OF TRANSPORTATION CLASSIFICATION
THIS MATERIAL IS NOT SUBJECT TO DOT REGULATIONS UNDER 49 CFR PARTS 171-180.

THIS PRODUCT IS AN OIL UNDER 49CFR (DOT) PART 130. IF SHIPPED BY RAIL OR HIGHWAY IN A TANK WITH A CAPACITY OF 3500 GALLONS OR MORE, IT IS SUBJECT TO THESE REQUIREMENTS. MIXTURES OR SOLUTIONS CONTAINING 10% OR MORE OF THIS PRODUCT MAY ALSO BE SUBJECT TO THIS RULE.

Oil

INTERNATIONAL AIR TRANSPORTATION ASSOCIATION:
NO REGULATED UNDER IATA RULES.

INTERNATIONAL MARITIME ORGANIZATION CLASSIFICATION:
NOT REGULATED UNDER INTERNATIONAL MARITIME ORGANIZATION RULES.

XV.**REGULATORY INFORMATION**

OSHA CLASSIFICATION:
PRODUCT IS HAZARDOUS ACCORDING TO THE OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 19.10.1200, BECAUSE IT CARRIES THE OCCUPATIONAL EXPOSURE LIMIT FOR MINERAL OIL MIST.

OZONE DEPLETING SUBSTANCES (40 CFR 82 CLEAN AIR ACT)::
I OR CLASS II OZONE DEPLETING SUBSTANCES.

SUPERFUND AMENDMENT & REAUTHORIZATION ACT (SARA) TITLE III:
THERE ARE NO COMPONENTS IN THIS PRODUCT ON THE SARA 302 LIST.

SARA HAZARD CATEGORIES (311/312):

IMMEDIATE HEALTH: NO
DELAYED HEALTH: NO
FIRE: NO
PRESSURE: NO
REACTIVITY: NO

SARA TOXIC RELEASE INVENTORY (TRI) (313):
THERE ARE NO COMPONENTS IN THIS PRODUCT ON THE SARA 313 LIST.

TOXIC SUBSTANCES CONTROL ACT (TSCA) STATUS:
THIS MATERIAL IS LISTED ON THE EPA/TSCA INVENTORY OF CHEMICAL SUBSTANCES.

OTHER CHEMICAL INVENTORIES:

AUSTRALIAN AICS, CANADIAN DSL, CHINESE INVENTORY, EUROPEAN EINECS, JAPAN ENCS, KOREAN INVENTORY, PHILIPPINES PICCS

STATE REGULATION:

THIS MATERIAL IS NOT REGULATED BY CALIFORNIA PROP 65, NEW JERSEY RIGHT-TO-KNOW CHEMICAL LIST OR PENNSYLVANIA RIGHT-TO-KNOW CHEMICAL LIST. HOWEVER FOR DETAILS ON YOUR REGULATION REQUIREMENTS YOU SHOULD CONTACT THE APPROPRIATE AGENCY IN YOUR STATE.

XVI.**OTHER INFORMATION**

HMIS RATING:
(HEALTH, FIRE, REACTIVITY): 0, 1, 0

REVISION #: 0

REVISION DATE:
07/05/2001

REVISIONS SINCE LAST CHANGE (DISCUSSION):

THIS MATERIAL SAFETY DATA SHEET (MSDS) HAS BEEN NEWLY CREATED TO FULLY COMPLY WITH THE GUIDANCE CONTAINED IN THE ANSI MSDS STANDARD (ANSI Z400.1-1998). WE ENCOURAGE YOU TO TAKE THE OPPORTUNITY TO READ THE MSDS AND REVIEW THE INFORMATION CONTAINED THEREIN.

MSDS No.

Rev. Date 4/8/03

CRYSTAL 100 BASE OIL

XVII.

LABEL INFORMATION

READ AND UNDERSTAND MATERIAL SAFETY DATA SHEET BEFORE HANDLING OR DISPOSING OF PRODUCT. THIS LABEL COMPLIES WITH THE REQUIREMENTS OF THE OSHA HAZARD COMMUNICATION STANDARD (29 CFR 1910.1200) FOR USE IN THE WORKPLACE. THIS LABEL IS NOT INTENDED TO BE USED WITH PACKAGING, INTENDED FOR SALE TO CONSUMERS AND MAY NOT CONFORM WITH THE REQUIREMENTS OF THE CONSUMERS AND MAY NOT CONFORM WITH THE REQUIREMENTS OF THE CONSUMER PRODUCT SAFETY ACT OR OTHER RELATED REGULATORY REQUIREMENTS.

PRODUCT CODES:
07235

CRYSTAL 100 BASE OIL

CAUTION!

ASPIRATION HAZARD IF SWALLOWED - CAN ENTER LUNGS AND CAUSE DAMAGE. PROLONGED OR REPEATED SKIN CONTACT MAY CAUSE OIL ACNE OR DERMATITIS.

PRECAUTIONARY MEASURES:

AVOID PROLONGED OR REPEATED CONTACT WITH EYES, SKIN AND CLOTHING. DO NOT TAKE INTERNALLY.

FIRST AID:

INHALATION: REMOVE VICTIM TO FRESH AIR AND PROVIDE OXYGEN IF BREATHING IS DIFFICULT. GET MEDICAL ATTENTION.

SKIN CONTACT: REMOVE CONTAMINATED CLOTHING AND SHOES AND WIPE EXCESS FROM SKIN. FLUSH SKIN WITH WATER, THEN WASH WITH SOAP AND WATER. IF IRRITATION OCCURS, GET MEDICAL ATTENTION. DO NOT REUSE CLOTHING UNTIL CLEANED.

EYE CONTACT: FLUSH WITH WATER. IF IRRITATION OCCURS, GET MEDICAL ATTENTION.

INGESTION: DO NOT INDUCE VOMITING. IF VOMITING OCCURS SPONTANEOUSLY, KEEP HEAD BELOW HIPS TO PREVENT ASPIRATION OF LIQUID INTO LUNGS. GET MEDICAL ATTENTION.

FIRE:

IN CASE OF FIRE, USE WATER FOG, 'ALCOHOL FOAM', DRY CHEMICAL OR CARBON DIOXIDE (CO₂) TO EXTINGUISH FLAMES. DO NOT USE A DIRECT STREAM OF WATER. MATERIAL WILL FLOAT AND CAN BE RE-IGNITED ON SURFACE OF WATER.

SPILL OR LEAK:

DIKE AND CONTAIN SPILL.

FOR LARGE SPILLS: REMOVE WITH VACUUM TRUCK OR PUMP TO STORAGE/SALVAGE VESSELS.

FOR SMALL SPILLS: SOAK UP RESIDUE WITH AN ABSORBENT SUCH AS CLAY, SAND OR OTHER SUITABLE MATERIAL. PLACE IN NON-LEAKING CONTAINER AND SEAL TIGHTLY FOR PROPER DISPOSAL.

CONTAINS:

HYDROTREATED HEAVY PARAFFINIC DISTILLATE, 64742-54-7

NFPA RATING (HEALTH, FIRE, REACTIVITY): 0, 1, 0

HMIS RATING (HEALTH, FIRE, REACTIVITY): 0, 1, 0

TRANSPORTATION:

US DEPARTMENT OF TRANSPORTATION CLASSIFICATION.

THIS MATERIAL IS NOT SUBJECT TO DOT REGULATIONS UNDER 49 CFR PARTS 171-180.

OIL: THIS PRODUCT IS AN OIL UNDER 49CFR (DOT) PART 130. IF SHIPPED BY RAIL OR HIGHWAY IN A TANK WITH A CAPACITY OF 3500 GALLONS OR MORE, IT IS SUBJECT TO THESE REQUIREMENTS. MIXTURES OR SOLUTIONS CONTAINING 10% OR MORE OF THIS PRODUCT MAY ALSO BE SUBJECT TO THIS RULE.

CAUTION:

MISUSE OF EMPTY CONTAINERS CAN BE HAZARDOUS. EMPTY CONTAINERS CAN BE HAZARDOUS IF USED TO STORE TOXIC, FLAMMABLE, OR REACTIVE MATERIALS. CUTTING OR WELDING OF EMPTY CONTAINERS MIGHT CAUSE FIRE, EXPLOSION OR TOXIC FUMES FROM RESIDUES. DO NOT PRESSURIZE OR EXPOSE TO OPEN FLAMES OR HEAT. KEEP CONTAINER CLOSED AND DRUM BUNGS IN PLACE.

NAME AND ADDRESS: STE OIL COMPANY, INC.
2001 CLOVIS BARKER ROAD
SAN MARCOS, TX 78666
(512) 396-3399

TRANSPORTATION EMERGENCY: CHEMTEL (800) 424-9300
HEALTH EMERGENCY: CHEMTEL (800) 424-9300

ADMINISTRATIVE INFORMATION:

COMPANY ADDRESS: STE OIL COMPANY, INC., 2001 CLOVIS BARKER ROAD, SAN MARCOS, TX 78666

COMPANY PRODUCT STEWARDSHIP & REGULATORY COMPLIANCE CONTACT: AL EMFINGER

PHONE NUMBER: (512) 396-3399

MSDS FAX-BACK PHONE NUMBER: (512) 396-3465

MSDS No.

CRYSTAL 100 BASE OIL

Rev. Date 4/8/03

XVII.

LABEL INFORMATION (CONT'D)

THE INFORMATION CONTAINED IN THIS DATA SHEET IS BASED ON THE DATA AVAILABLE TO US AT THIS TIME, AND IS BELIEVED TO BE ACCURATE BASED UPON THAT DATA. IT IS PROVIDED INDEPENDENTLY OF ANY SALE OF THE PRODUCT, FOR PURPOSE OF HAZARD COMMUNICATION. IT IS NOT INTENDED TO CONSTITUTE PRODUCT PERFORMANCE INFORMATION, AND NO EXPRESS OR IMPLIED WARRANTY OF ANY KIND IS MADE WITH RESPECT TO THE PRODUCT, UNDERLYING DATA OR THE INFORMATION CONTAINED HEREIN. YOU ARE URGED TO OBTAIN DATA SHEETS FOR ALL PRODUCTS YOU BUY, PROCESS, USE OR SUCH PRODUCTS OF THE INFORMATION CONTAINED HEREIN.

TO DETERMINE THE APPLICABILITY OR EFFECT OF ANY LAW OR REGULATION WITH RESPECT TO THE PRODUCT, YOU SHOULD CONSULT WITH YOUR LEGAL ADVISOR OR THE APPROPRIATE GOVERNMENT AGENCY. WE WILL NOT PROVIDE ADVICE ON THE SUCH MATTERS, OR BE RESPONSIBLE FOR ANY INJURY FROM THE USE OF THE PRODUCT DESCRIBED HEREIN. THE UNDERLYING DATA, AND THE INFORMATION PROVIDED HEREIN AS A RESULT OF THAT DATA, IS THE PROPERTY OF EQUIVA SERVICES LLC AND IS NOT TO BE THE SUBJECT OF SALE OR EXCHANGE WITHOUT THE EXPRESS WRITTEN CONSENT OF EQUIVA SERVICES LLC.

Support Document 9

**Penniman & Browne Laboratory Analysis for Physical Properties of Reformulated
Liquid Wrench**



**PENNIMAN
& BROWNE,
INC.**

**CHEMISTS / ENGINEERS / INSPECTORS
INDUSTRIAL HYGIENE SERVICES
FOUNDED 1896**

Prepared for:

Environmental Profiles
Dale Johnson
8805 Columbia 100 Parkway, Suite 100
Columbia, MD 21045

Certificate of Analysis

6/11/2009

Sample Information

Sample Number	90002166-01	Matrix	Miscellaneous Liquid			
Sample ID	LW-Reform-1	Sample Date/Time	06/09/09			
Description	Mixed Oil and Additives	Sampler	Client			
<hr/>						
Analysis	Units	Limits	Results	Analyst	Date / Time Tested	Method
Flash Point ° F	° F	Report	87	GS	06/11/2009 10:30	ASTM D56
Specific Gravity @ 60°/60° F	60°/60° F	Report	0.7883	GS	06/11/2009 11:30	ASTM D1298
IBP (distillation)	° F	Report	158.0	GS	06/11/2009 10:35	ASTM D86
Fuel Status	Pass / Fail	Pass / Fail	Pass	GS	06/11/2009 12:05	

Gary Sugal - Lab Technician

Barbara Schroyer, Laboratory Director

EPI00027

This report may be reproduced only in its entirety. The results are valid only for the item(s) tested. They are provided to the client on a confidential basis and, to the extent of the law, will not be released to third parties without authorization.

Support Document 10

Dr. Adam Keil's Benzene Evaporation Study, Direct Sampling Mass Spectrometer Method Development and Data Collection Summary

Benzene Evaporation Study

Direct Sampling Mass Spectrometer Method Development and Data Collection Summary

Prepared for:
Environmental Profiles, Inc.

Prepared by:
Adam Keil, Ph.D.

June 22, 2009

	Page
I. Introduction.....	2
II. Method Development.....	3
II-a. Pre-concentration inlet evaluation.....	4
II-b. Direct leak inlet evaluation.....	7
III. Calibration.....	8
III-a. Measurement precision and error.....	9
III-b. Confounders and interferences.....	10
IV. Pure Benzene Evaporation.....	14
V. Liquid Wrench Evaporation.....	17
V-a. Liquid Wrench Pours.....	17
V-b. Liquid Wrench used on parts.....	19
VI. Conclusions.....	21

I. Introduction

In order to investigate and quantify the gas phase concentration of benzene evolved from an evaporating pool of both the neat compound and a complex hydrocarbon mixture containing benzene, direct sampling mass spectrometer was employed, sampling downstream from the evaporating benzene or mixture. The direct sampling mass spectrometer offers a distinct advantage over other more traditional gas phase sampling methodologies with respect to the frequency at which benzene concentration can be obtained. Using no chromatographic separation and simply leaking a small amount of sample into the vacuum chamber of the mass spectrometer to be ionized with the resulting ions separated by mass to charge ration, a direct sampling mass spectrometer can deliver data at up to 10 Hz. Traditional gas phase methods for the detection and quantification of benzene rely on chromatographic techniques to separate benzene from other compounds in the air, and the acquisition of one benzene concentration data point may take more than 30 minutes. Moreover, collection media are often involved, requiring the user to sample air over or into the media and forward the collected sample to a separate laboratory for analysis. Because the parameters of the presently discussed study would dictate that the benzene would evaporate in a matter of minutes and the direct sampling mass spectrometer allows for the real-time collection of benzene concentration data, the technique was deemed appropriate and necessary. Although not accomplished in this study, the method could potentially allow for the quantitative interrogation of the other compounds present in a benzene-containing mixture as well.

The direct sampling mass spectrometer chosen for this work was the ICx Analytical Instruments' ChemSense 600. After-market options exist that can add direct sampling capabilities to other mass spectrometers, but the ChemSense is the only commercially available mass spectrometer specifically designed as a direct sampling unit. Optimized for the automated detection of chemical warfare agents and toxic industrial compounds, the ChemSense is also able to interrogate, quantitatively, gas phase species such as benzene, even in complex hydrocarbon mixtures. Additionally, the author's familiarity with this piece of chemical instrumentation, having helped to design and test pre-production models, contributed to its selection for this work.

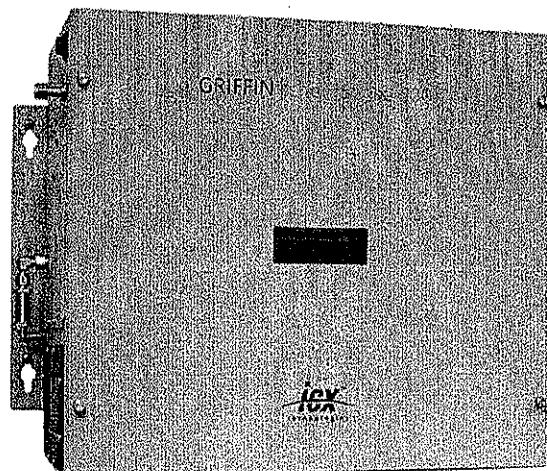


Figure 1. ICx Analytical Instruments' ChemSense 600 Direct Sampling Mass Spectrometer.

The ChemSense mass spectrometer uses a cylindrical ion trap mass analyzer¹ (CIT) to separate ions according to their mass-to-charge ratios. Ions are created inside of the CIT by electron ionization. These electrons are generated in a glow discharge source. Neutral sample compounds are admitted to the vacuum chamber, within which the CIT and glow discharge source reside, through either a capillary restriction or upon being thermally desorbed from sorbent media upon which they are preconcentrated during sampling³.

II. Method Development

Initial method development questions to be answered included the question of whether the capillary leak inlet, which would provide data frequencies greater than 1 Hz, or the sorbent tube preconcentration inlet system (providing a data point approximately every 30 s) would provide the best data quality for the benzene evaporation rate study. Both inlet options were initially considered and characterized by exposing the ChemSense to gas phase benzene at various concentrations generated by diluting (to various degrees) a 5 ppm pre-mixed benzene cylinder with zero air (less than 1 ppm hydrocarbons). Figure 2 represents the system used to generate benzene at various gas phase

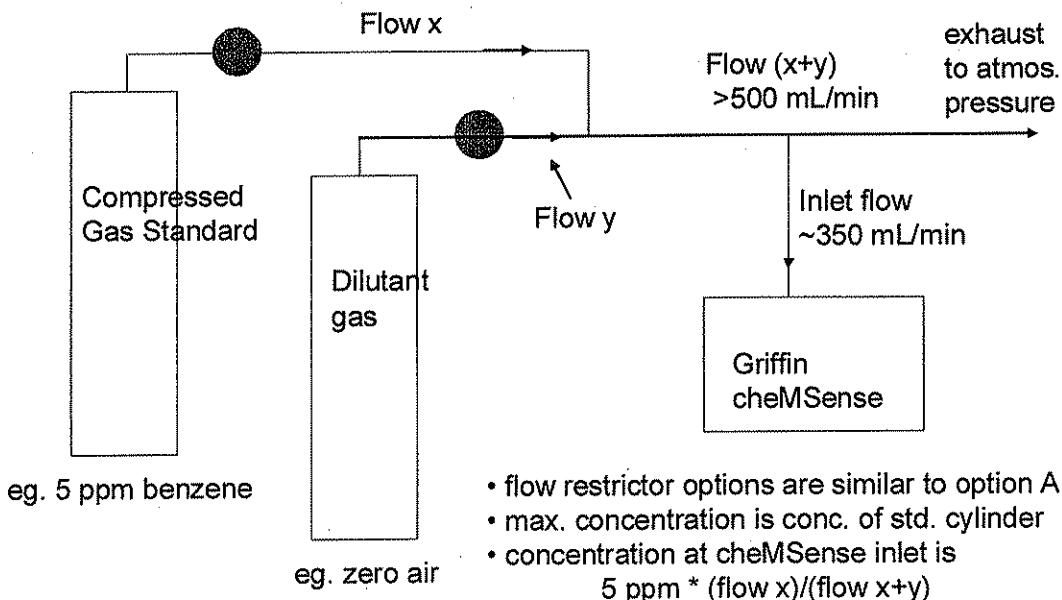


Figure 2. Schematic representation of the inlet characterization and calibration system with performance and limitation notes

concentrations for use in characterizing both potential mass spectrometer inlet modes and in calibrating the mass spectrometer.

Mass spectrometers may be programmed, usually through the control software, to record data in several different manners. The CIT in the ChemSense is capable of performing full scan mass analyses, where the ion signal over a broad mass-to-charge range is recorded continuously. This method of mass analysis has the advantage of collecting data, potentially, for a broad range of chemical compounds that may be present in a mixture. Alternatively, data may only be recorded for ions of a single mass-to-charge ratio, or more advanced techniques, like tandem mass spectrometry, in which ions are intentionally fragmented inside the CIT, may be employed. In order to gain the most information about benzene and the other

compounds present in the mixtures studied in this work, data was recorded over a mass-to-charge range of 50 to 150. This mass-to-charge range includes the dominant ion signals from most of the compounds anticipated to be in the mixtures studied.

Other important instrument

Table 1. Important mass spectrometer parameters

Item, setpoint, or other characteristic	Value or notation
Vacuum manifold pressure	$>1.5 \times 10^{-5}$ torr
CIT bath gas	air
Inlet manifold temperature	130 C
Inlet flow rate	360 mL/min
Particulate filter temperature	95 C
Electron multiplier bias	1300 V
CIT temperature	130 C

parameters which may be important for the future replication of this work are included in Table 1.

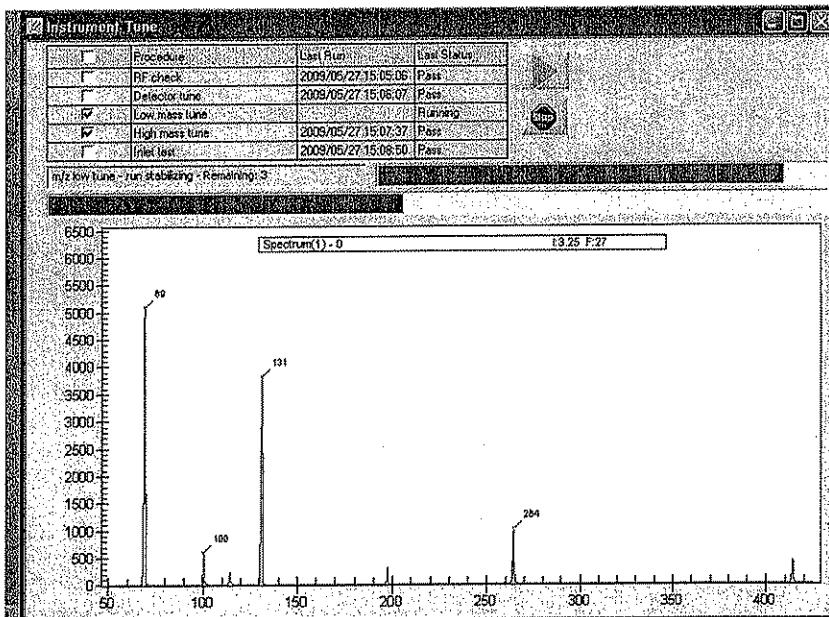


Figure 3. Mass spectrum indicating the mass-to-charge calibration of the ChemSense is correct. This check was performed daily prior to data collection for the day.

Prior to each day's data collection, the ChemSense's mass-to-charge axis was calibrated by running a software controlled tuning procedure called "low m/z tune." Figure 3 shows the resulting mass spectrum of the calibration compound, perfluorotributyl-amine.

II-a. Pre-concentration inlet evaluation

The ChemSense is

equipped with two separate sorbent tubes packed with Tenax TA and Carboseive 369. Sample is drawn through these tubes, across the sorbent media, upon which analyte molecules adhere. In this way, analyte from several hundred milliliters of sample air can be concentrated onto the media. After the preconcentration step, the analyte molecules are thermally desorbed directly into the vacuum system and into the CIT for ionization. This inlet method has the advantage of being able to achieve very low limits of detection. However, since the preconcentration step can take several seconds, concentration data may only be available about every 30 seconds with its use. Figure 4 shows preconcentration inlet data for benzene recorded using the ChemSense 600 during the evaluation portion of this study.

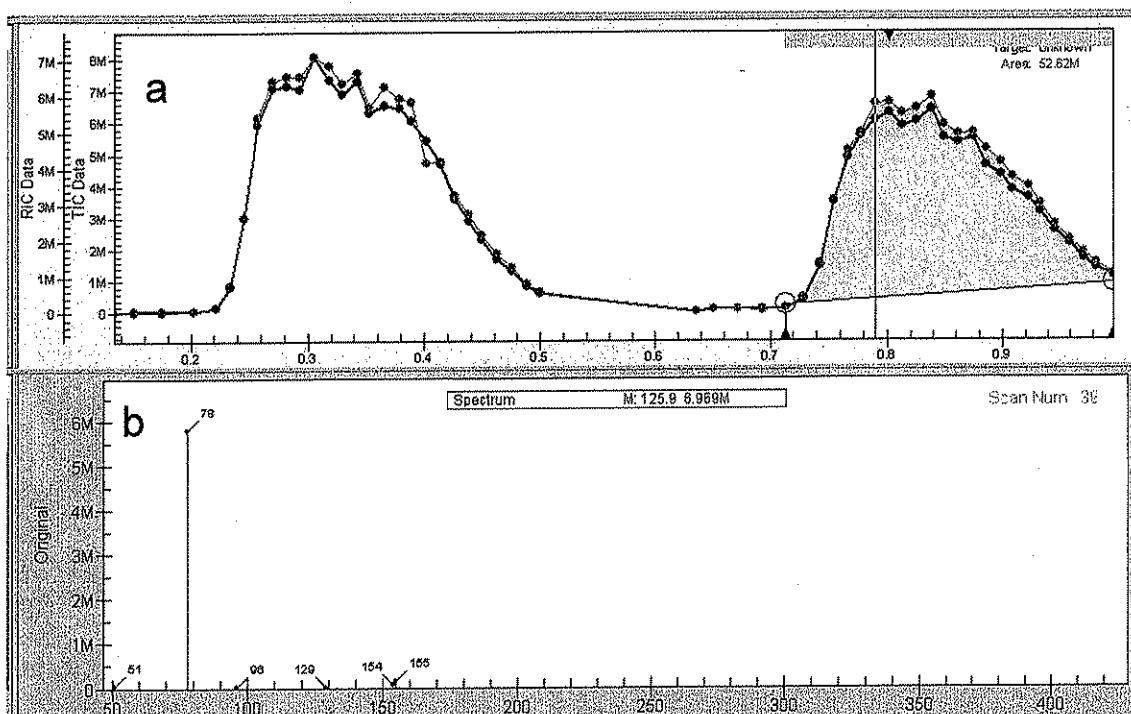


Figure 4. Mass spectrometric data collected for benzene using the sorbent tube preconcentration inlet of the ICx ChemSense direct sampling mass spectrometer. The top panel, "a," shows total ion signal over the mass-to-charge range 50-150 versus time for two separate sorbent tube desorptions into the mass spectrometer. As heat is applied, analyte, in this case benzene, evolves from the sorbent media. This results in an increase and subsequent decrease in analyte signal, forming a peak when plotted as signal versus time as in panel "a." Each peak results from the desorption of one or the other sorbent tube, and the area under each peak is proportional to the amount of analyte collected on the sorbent media, which is in turn proportional to the gas phase analyte concentration. Panel "a" shows data for 1.249 ppm benzene in air. Panel "b" shows the mass spectral data for the second peak in panel "a." Ionization of benzene by electron impact results in ion signal at mass-to-charge 78, as is shown in panel "b."

In addition to the 30 second interval between data points achievable with the preconcentration inlet of the ChemSense, a significant disadvantage with respect to quantitation is analyte carryover, especially at part per million concentration levels of organic compounds. This inlet is especially useful at much lower (i.e. part per billion or lower) concentrations of organics, but at higher concentrations all of the analyte

may not be removed from the sorbent media during the thermal desorption, resulting in some "leftover" analyte being desorbed during subsequent desorption events. This results in erroneously high signal levels on those subsequent events, and is often termed "carryover." In an attempt to investigate carryover, the mass spectrometer was exposed to 1.25 ppm benzene for one sampling cycle, then to zero air (containing no benzene) for 11 more sampling cycles. Benzene signal in any sample subsequent to the 1.25 ppm benzene sample can be determined to be carryover, and the interrogation of any carryover for several zero air samples can indicate how long carryover persists. Figure 5 shows the resulting data.

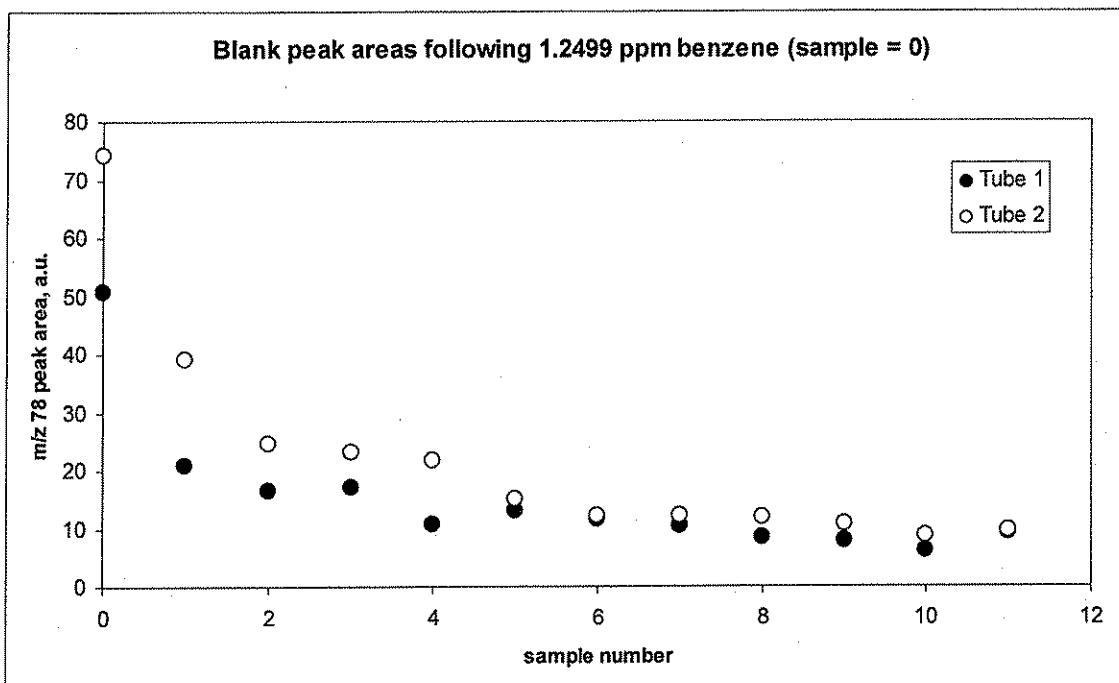


Figure 5. Carryover data for the ChemSense 600 sorbent preconcentration inlet sampling 1.25 ppm benzene (sample no. 0). Subsequent sample numbers are zero air, and indicate significant carryover. Peak areas for m/z 78 are shown for both sorbent tube channels in the mass spectrometer.

From Figure 5, it is evident that the first zero air sample after a 1.25 ppm benzene sample shows signal for benzene at about 20%. This was deemed unacceptable for this study. Instrumental parameters such as sampling times, sorbent media heating times, and sorbent media ultimate temperatures were adjusted and had good impact on the resulting carryover, but levels were never diminished significantly enough for the inlet to be suitable to the study.

Nonetheless, a calibration was performed using the preconcentration inlet of the ChemSense. The results are shown in Figure 6.

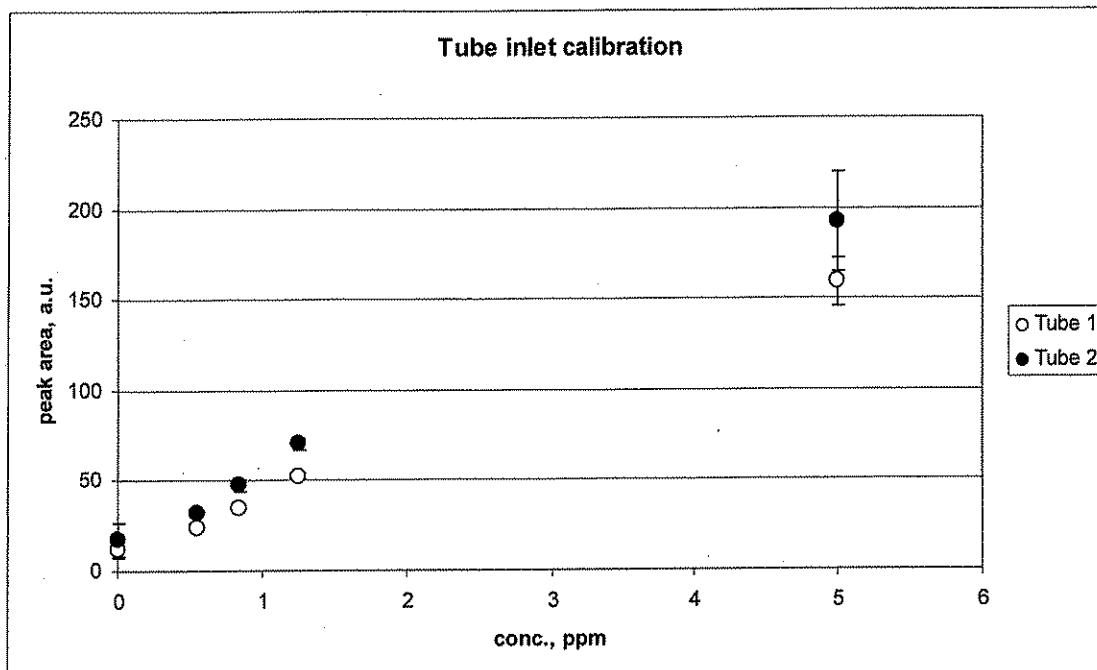


Figure 6. Benzene calibration using the preconcentration inlet of the ChemSense 600. Peak area of m/z 78 is plotted versus benzene concentration for both inlet channels of the mass spectrometer. The error bars represent one standard deviation for a population of 3 replicates at each concentration, except 0 ppm benzene where there were 10 replicate measurements. The significant signal at 0 ppm is likely because of the significant carryover. No intense effort was made to investigate this, however.

II-b. Direct leak inlet evaluation

The direct leak inlet of the ChemSense mass spectrometer is a small bore capillary that lets a small flow of air from the sample stream directly into the vacuum system of the detector. Since there is no preconcentration or event distinct sampling event, the resulting data is continuous and, including some averaging, recorded at about 1 Hz. With such data frequency, it is possible to monitor rapid changes in analyte concentration—an important feature with respect to the benzene evaporation study. Figure 7 illustrates the rise and fall time for the direct leak inlet. At 2.0 minutes, the mass spectrometer's sample inlet was removed from a flowing zero air stream and connected to a flowing stream of 5 ppm benzene in air. The resulting increase in signal intensity is very rapid. At 4.0 minutes, the sample inlet was removed from the 5 ppm benzene and returned to the zero air stream, with a corresponding rapid decrease in signal to the original level. No carryover is observed, and the rapidity of both the signal increase and decrease indicate the direct leak inlet is appropriate, at least with respect to measurement frequency and response characteristics, for the benzene evaporation study.

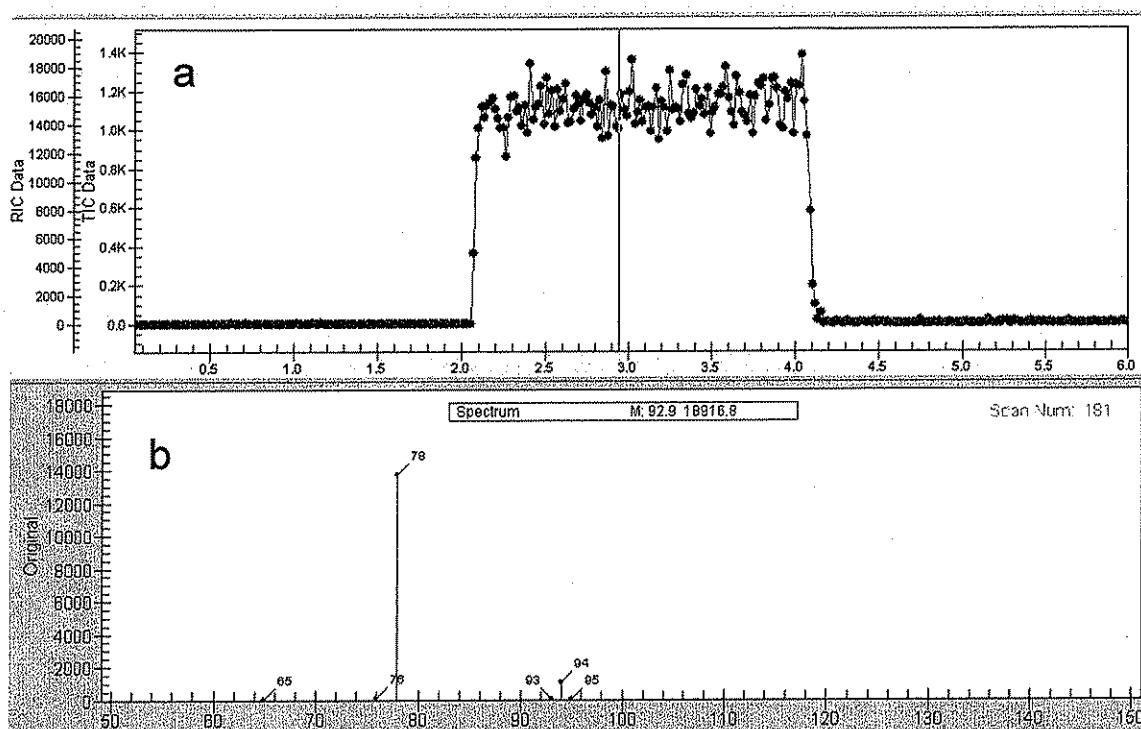


Figure 7. Illustration of the rise/fall time for the direct leak inlet of a ChemSense mass spectrometer sampling benzene. Panel "a" shows the benzene signal versus time. At 2.0 minutes, the inlet was removed from zero air and exposed to 5 ppm benzene until 4.0 minutes, when it was returned to clean air. Panel "b" shows a mass spectrum for the 5 ppm benzene.

III. Calibration

A calibration of the direct leak inlet was performed from 0 to 230 ppm benzene in anticipation of the concentrations to be observe in the benzene evaporation study. The data is listed in Table 2 and shown graphically in Figure 8.

Table 2. Signal averages and standard deviations for the benzene direct leak calibration.

Benzene Concentration	Signal Average	Standard Deviation	Std. Dev. as %
0.00	9.61	30.33	315.5%
5.00	18066.61	1500.04	8.3%
1.09	3764.61	754.59	20.0%
1.89	8373.89	1043.30	12.5%
0.48	2255.72	582.22	25.8%
49.96	174722.15	6505.62	3.7%
230.00	697004.36	26548.68	3.8%

From these calibration data, one can calculate a limit of detection (defined herein as a concentration corresponding to 3 times the standard deviation of a blank measurement) of 30 parts per billion, and a limit of quantitation (10 times the standard deviation of a blank measurement) of 100 parts per billion. These limits were deemed acceptable for the benzene evaporation rate study. The acceptable

limits of detection and rapid response time of the direct leak inlet led to the decision to use it as the sampling interface for the remainder of the study.

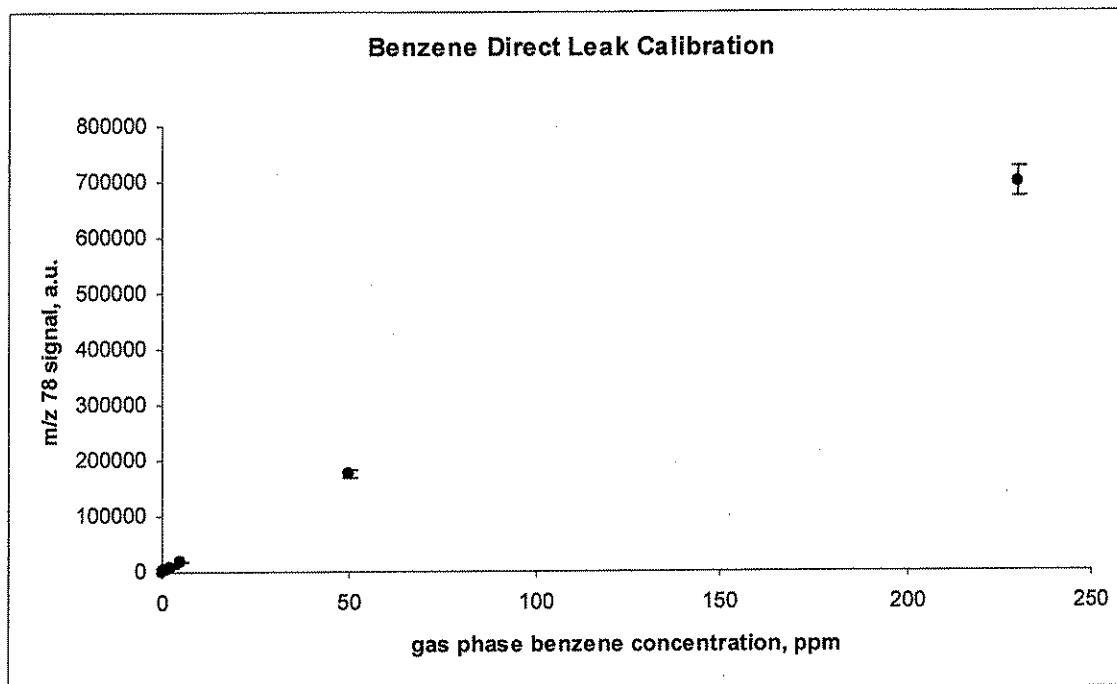


Figure 8. Benzene calibration using the direct leak inlet of a ChemSense 600, signal versus gas phase concentration of benzene sampled. Each data point plotted represents the average of approximately 300 data point for samples containing benzene, and approximately 1100 data points for blank (zero air) samples. Error bars (barely discernable at low concentrations) represent one standard deviation of the average signal.

III-a. Measurement precision and error

For samples that contain pure benzene, the relative uncertainty (error) associated with any single concentration measurement can be express by Equation 1, where $RU_{\text{benzene concentration}}$ is the relative uncertainly of the calculated

$$RU_{\text{benzene concentration}} = \sqrt{(RU_{\text{std. cyl. conc.}})^2 + (RU_{\text{bubble meter volume}})^2 + (RU_{\text{stop watch error}})^2 + (\text{MS precision})^2} \quad \text{Eqn. 1}$$

benzene concentration, $RU_{\text{std. cyl. conc.}}$ is the relative error in the standard benzene cylinder concentrations (2% as expressed by the manufacturer), $RU_{\text{bubble meter volume}}$ and $RU_{\text{stop watch error}}$ are the relative errors in the bubble meter volume and stopwatch readings, respectively (both used to measure flow rates during benzene gas phase standard generation, and both assumed to be 1%), and MS precision is the precision of the mass spectrometers output. This precision is concentration dependent, as shown in Figure 9, and generally swamps all other errors, so Figure 9 can generally

be interpreted as the concentration dependent error rate. A detailed application of the error analysis is included in Figure 15, Section IV, for a pure benzene evaporation trial.

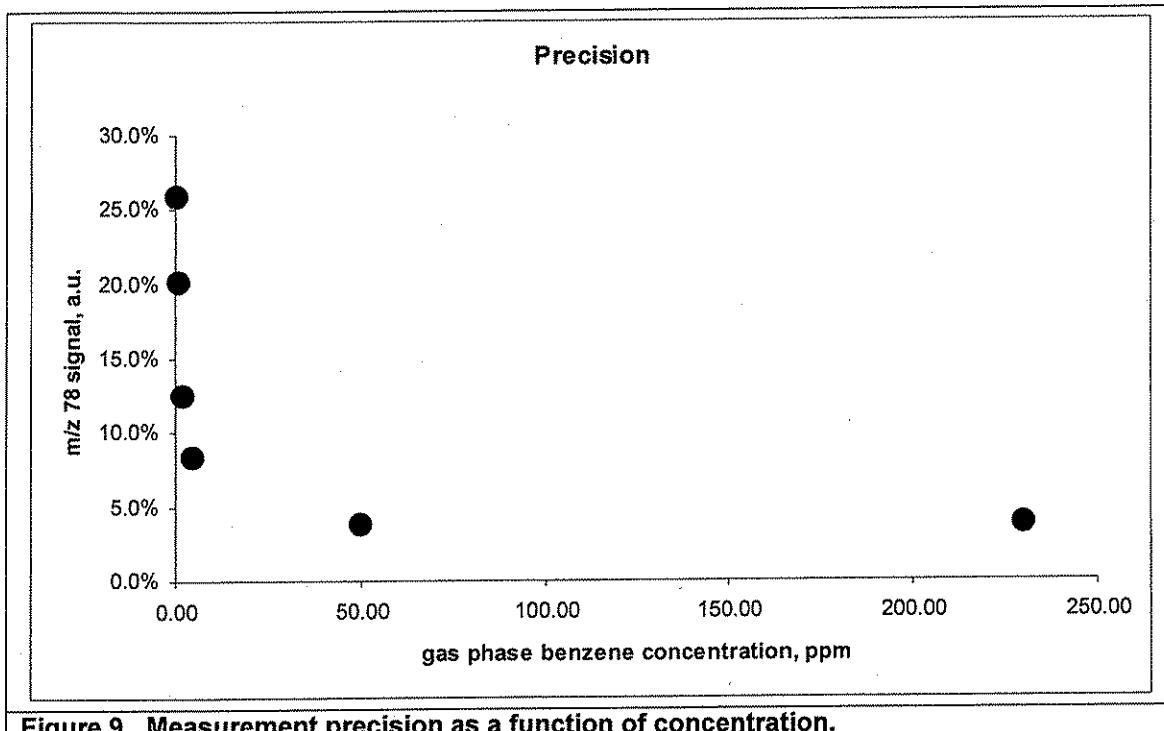


Figure 9. Measurement precision as a function of concentration.

III-b. Confounders and interferences

Since the direct inlet mass spectrometric technique uses no chromatographic separation, all of the chemical compounds present in a mixture are ionized and detected simultaneously. Figure 10 shows National Institute of Science and Technology standard reference mass spectra for the compounds anticipated to be detected in the gas phase during the evaporation of Liquid Wrench. Benzene clearly appears separated, according to mass-to-charge ratio, from the other compounds, but there is a slight contribution at mass-to-charge ratio 78 (characteristic of benzene) from ethyl benzene and mixed xylenes. When these compounds are ionized, approximately 10% (according to NIST) of the ions produced undergo fragmentation that results in ions with a mass-to-charge ratio of 78.

To correct for this interference, a mixture of ethyl benzene and m-xylene was evaporated in the evaporation chamber, and the resulting data allowed for an experimental determination of the fraction of the ethyl benzene and xylene molecules that underwent this fragmentation. The ratio of signal for the parent ion (unfragmented ion) for ethyl benzene and the xylenes (defined as mass-to-charge 105-107) to that of the ion fragment that would contribute to the benzene signal (defined as mass-to-charge 77-79) was calculated over the entire evaporation

episode of this mixture. Figure 11, panel "b" shows the calculated ratio, which was used to correct benzene data for the mixtures containing benzene along with ethyl benzene and xylenes. The intensity at mass-to-charge 105-107 was multiplied

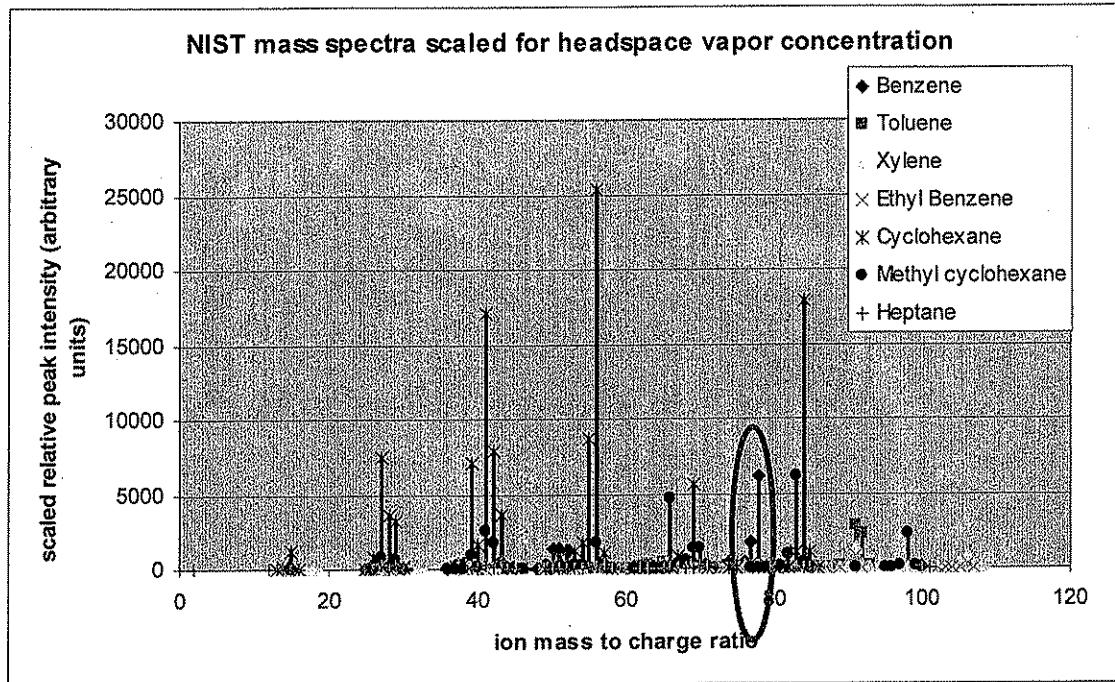


Figure 10. Standard NIST mass spectra (webbook.nist.gov) for the compounds anticipated to be observed evaporating from Liquid Wrench. Some signal at mass-to-charge 78 is contributed by ethyl benzene and is, therefore, an interference.

by 0.1038, and the result was subtracted from the intensity at mass-to-charge 78 for these mixtures. One standard deviation of the 0.1038 correction factor was calculated to be 0.0175, or 16.9% of the correction factor value.

For data that contains this signal correction, the relatively uncertainty of the corrected benzene concentration must contain a component dependent upon this correction. Since the correction involves subtraction from the indicated benzene signal, absolute error values, rather than relative error values, are required for use in the error analysis. Equation 2 represents the overall relative error of the

$$RU_{\text{corr. benzene conc.}} = \frac{AU_{\text{benzene conc.}} + AU_{\text{correction}}}{\text{benzene concentration}} \quad \text{Eqn. 2}$$

corrected benzene concentration values, where $AU_{\text{benzene conc.}}$ represents the absolute error of the uncorrected benzene concentration calculation, and $AU_{\text{correction}}$ represents the absolute error of the correction. The absolute error in the uncorrected concentration for any one data point is simply the relative error, expressed by Equation 1 multiplied by the observed concentration. The absolute

error of the correction factor is taken to be the intensity at mass-to-charge 105-107 multiplied by one standard deviation of the correction factor, 0.0175.

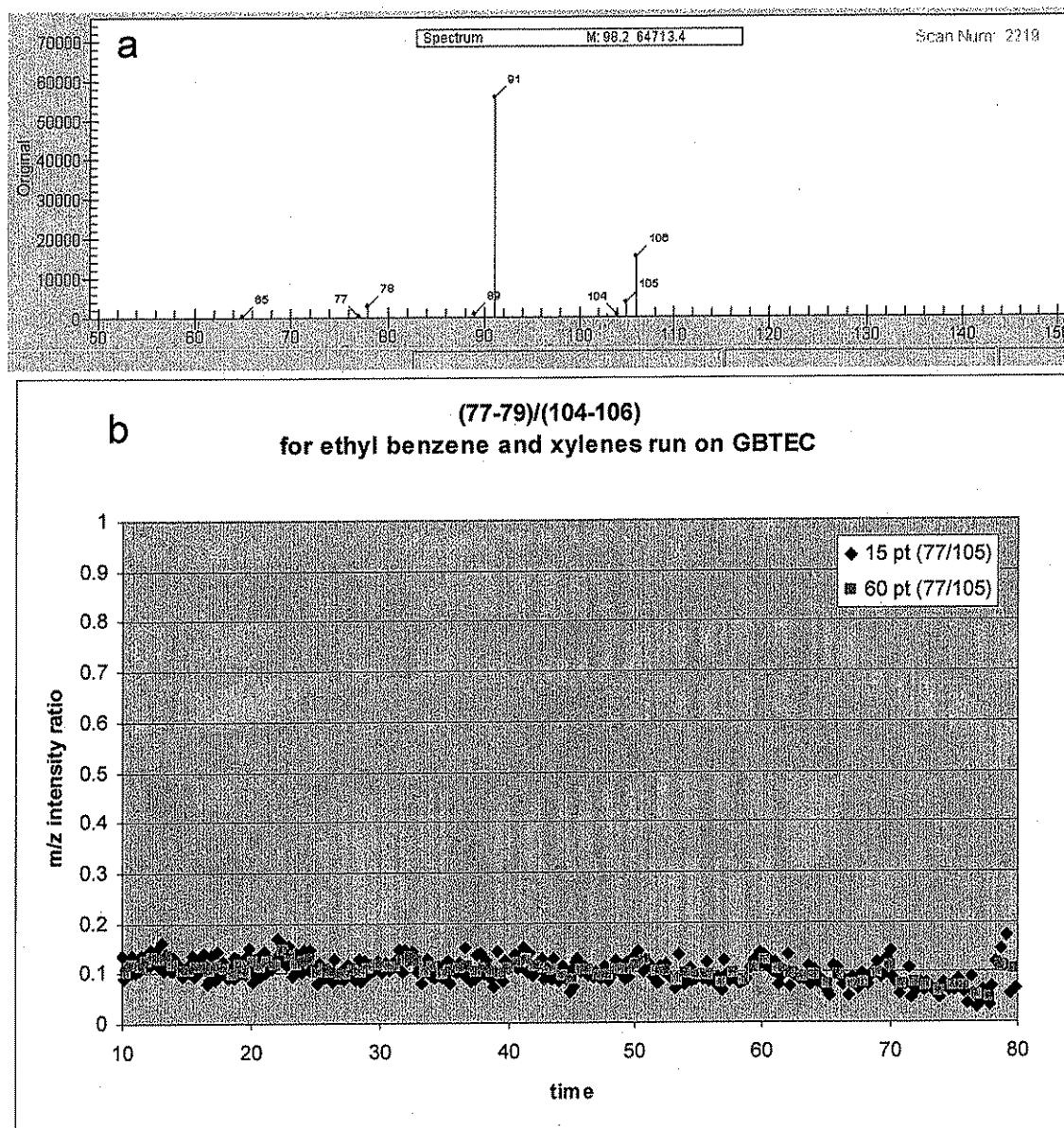


Figure 11. Mass spectrum of a mixture of ethyl benzene and xylene (panel "a") showing the contribution at mass-to-charge 78 of ethyl benzene. The bottom panel, "b," shows the ratio of the signals at mass-to-charge 105-107 to that at mass-to-charge 77-79 during the evaporation of a mixture of ethyl benzene and xylene in the flow system used for the benzene evaporation experiment. The ratio is nearly constant over the entire evaporation episode at 0.1038.

During the evaporation of Liquid Wrench, which contains approximately 5% of benzene by weight, it was noted that only about ½ of the benzene evaporated was observed at the mass spectrometer, based on mass balance calculations that multiplied observed concentrations by measured volumetric flow rate through the

evaporation apparatus. The evaporation of pure benzene gave very good mass balance values, so it was hypothesized that one or more compounds in the mixture was suppressing the signal attributed to benzene in the mass spectrometer. Several mixtures of benzene and cyclohexane were evaporated, and the resulting data was used to perform mass balance equations to ascertain if a relationship between the fraction of benzene in a mixture and the fraction of the total mass observed at the mass spectrometer could be obtained. Such a relationship exists, and is represented in Figure 12. Clearly, for mixtures with a low concentration of benzene, signal suppression is occurring. The exact mechanism of this signal suppression was not investigated, but it should be noted that there is absolutely no evidence to suggest this signal suppression, or "loss of benzene" is anything other than reduced sensitivity of the mass spectrometer for benzene in the presence of the other organic compounds. During the cyclohexane/benzene mixture data collection, all liquid evaporated within the evaporation apparatus, suggesting that while all the benzene made it into the gas phase, indicated concentrations at low benzene concentrations within the liquid mixture were suppressed. The "missing mass," then, is the result of the mass spectrometer, not the result of some physical or chemical process that destroys benzene or keeps it from evaporating.

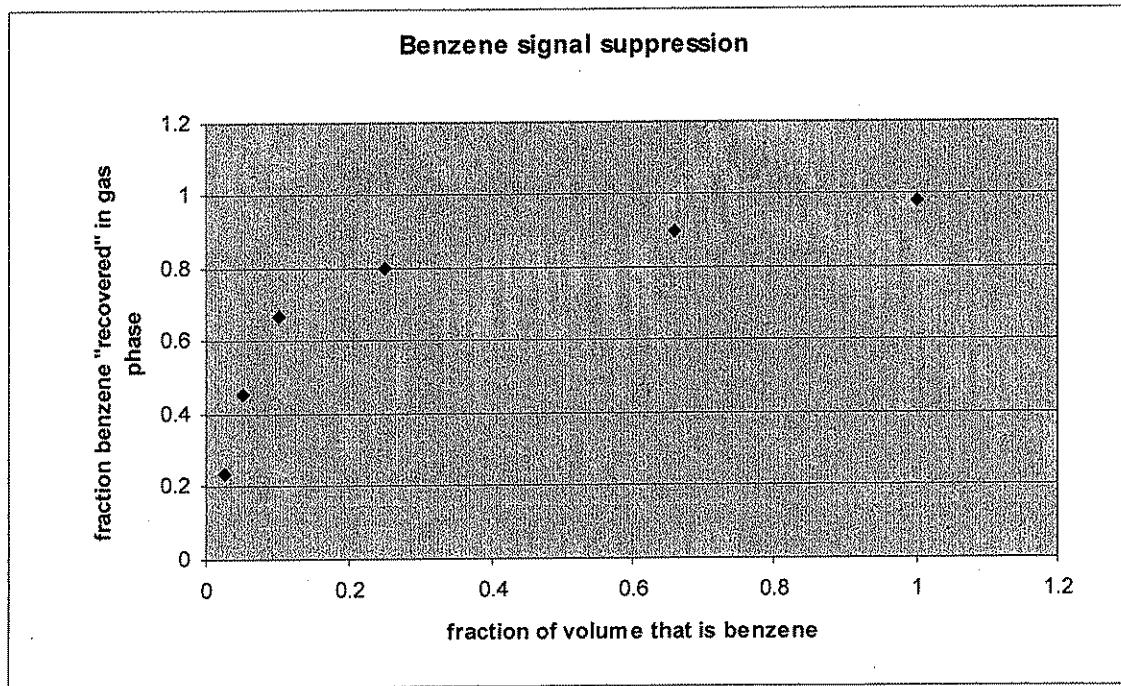


Figure 12. Fraction of benzene observed in the gas phase versus the fraction of an evaporated liquid mixture that is benzene. The balance of the liquid in this case is cyclohexane. For a 5% benzene mixture, the amount of benzene measured in the gas phase, over the course of the evaporation, was 46% of the total deposited into the evaporation chamber.

IV. Pure Benzene Evaporation

Four evaporation trials were performed using pure liquid benzene, 20 mL per trial, on June 10, 2009. In each trial, 20 mL was poured onto a glass plate and allowed to evaporate. Benzene concentrations were observed by the mass spectrometer down stream of the evaporating benzene pool. Figure 13 shows

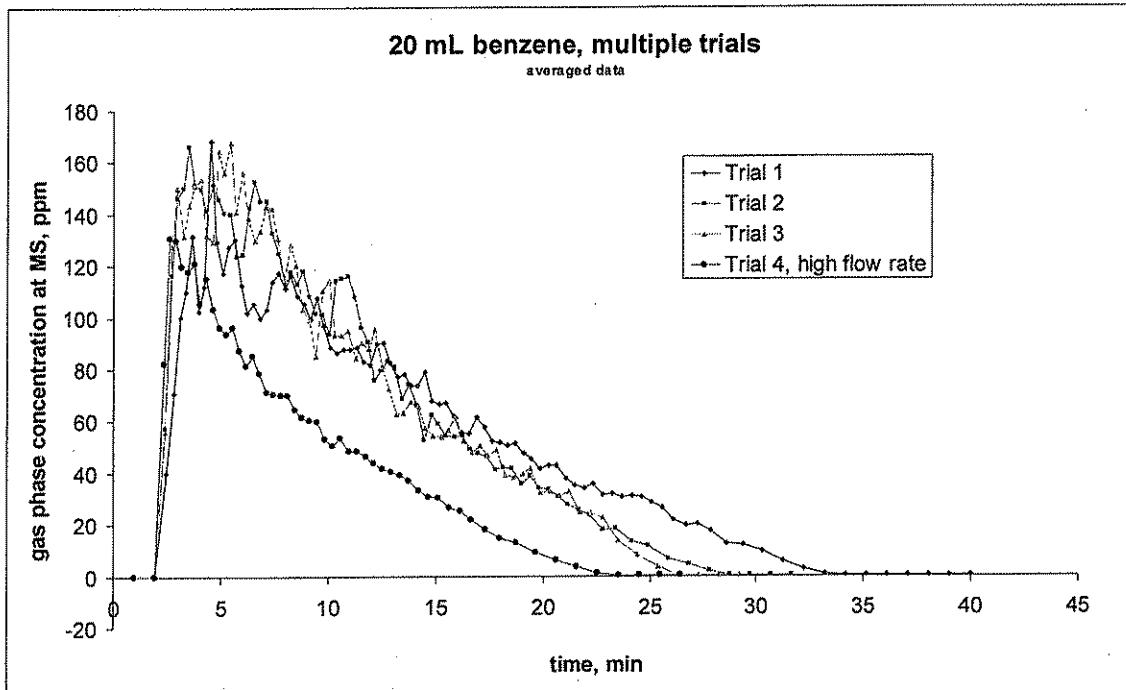


Figure 13. Observed gas phase benzene concentrations during the evaporation of pure benzene.

the observed benzene concentrations for each of the four trials. For the first three trials, the volumetric flow rate of air over the benzene pool was about 110 cu. ft. per minute, and about 195 cu. ft. per min for the fourth trial. For each trial, the total mass of benzene observed over the course of the evaporation can be calculated by multiplying observed concentration values by the volumetric flow rate, essentially calculating the area under the curves in Figure 13. These calculated benzene mass values can be compared with the known mass of benzene deposited for evaporation as in Table 3. Very good agreement exists between the observed mass values and the deposited mass values.

Figure 14 expresses the trial 3 benzene evaporation data slightly differently, showing the mass benzene evaporated versus time, based on the observed gas phase concentration and known volumetric air flow rate. The data clearly show that the half-life of evaporating benzene under these conditions is about 5.9 minutes.

Table 3. Mass balance calculation results for pure benzene evaporation.

Trial	Mass Deposited (g)	Mass Observed (g)	% difference
1	17.58	17.83	+1.4
2	17.58	17.19	-2.2
3	17.58	17.16	-2.4
4*	17.58	17.37	-1.1

* The volumetric air flow rate through the evaporation apparatus was approximately twice that for trial 4 as it was for trials 1-3.

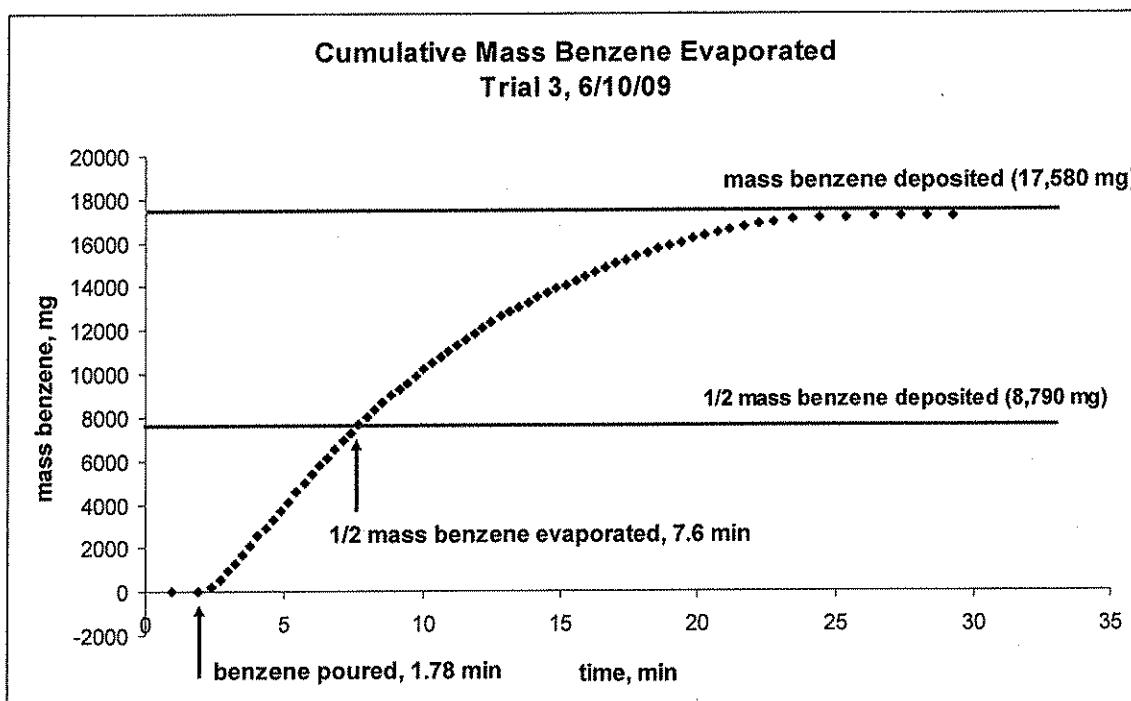


Figure 14. Benzene evaporation data for 20 mL benzene expressed as cumulative mass of benzene evaporated versus time. The benzene was poured at 1.78 minutes in this data, and $\frac{1}{2}$ of the total mass of the benzene has been detected in the gas phase at the sampling point at 7.6 minutes, indicating a half-life of 5.9 minutes.

Figure 15 shows the cumulative mass of benzene observed at the mass spectrometer for each of the pure benzene trials and the corresponding benzene half-lives for each trial. In each trial, the benzene was poured at 1.78 minutes in the recorded data. This time is taken into account (i.e. subtracted) in the benzene half-life calculations. For trials 1-4, respectively, the resulting benzene half-lives are 8.6, 6.8, 6.5, and 5.0 minutes, respectively.

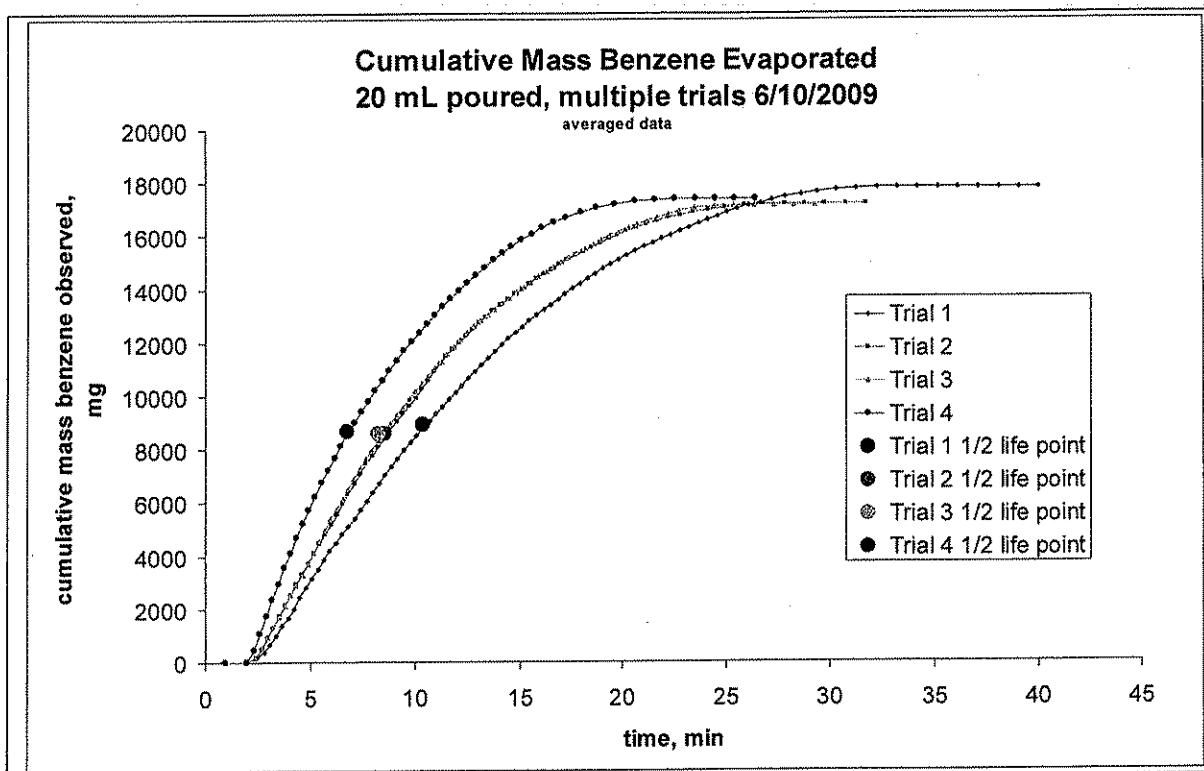


Figure 15. Cumulative mass benzene observed at the mass spectrometer for the 4 pure liquid benzene trials. For each trial, the points at which one half of the total mass benzene observed are emphasized. These data yield benzene half-lives of 8.6, 6.8, 6.5, and 5.0 minutes, respectively, for trials 1, 2, 3, and 4.

Applying the error analysis described in section III to Trial 3 of the pure benzene evaporation yields the data shown in Figure 16.

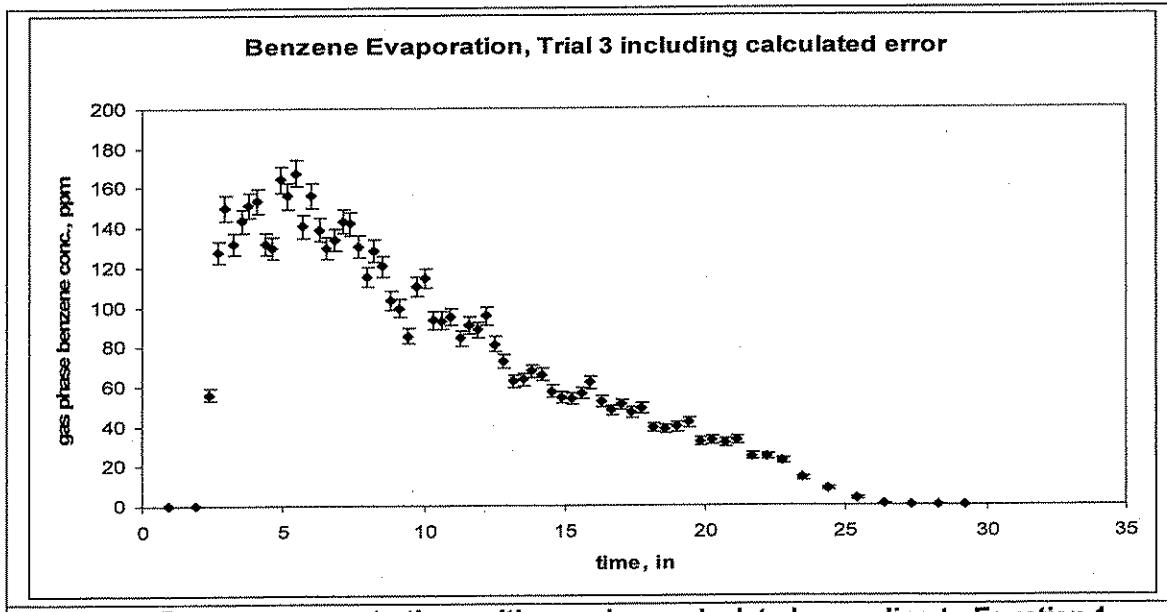


Figure 16. Benzene concentrations with error bars calculated according to Equation 1.

V. Liquid Wrench Evaporation

V-a. Liquid Wrench Pours

Four evaporation trials were performed using Liquid Wrench, 20 mL per trial, on June 11, 2009. In each trial, 20 mL of the mixture was poured onto a glass plate and allowed to evaporate. Benzene concentrations were observed by the mass spectrometer down stream of the evaporating Liquid Wrench pool. Figure 17 shows the observed benzene gas phase concentration values versus time for each Trial. As in the pure benzene trials, the fourth Liquid Wrench trial was at a volumetric flow rate about twice that of the first 3 trials.

For the Liquid Wrench evaporation trials, benzene mass balance values were calculated in the same manner as done for the pure benzene evaporation trials, and the results are summarized in Table 4. The mass balance calculations indicate that the benzene ionization suppression, as hypothesized and quantitatively characterized in Section III, is likely taking place, resulting in erroneously low gas phase concentration values (on the order of 25-50% low) that lead to low total mass observed values.

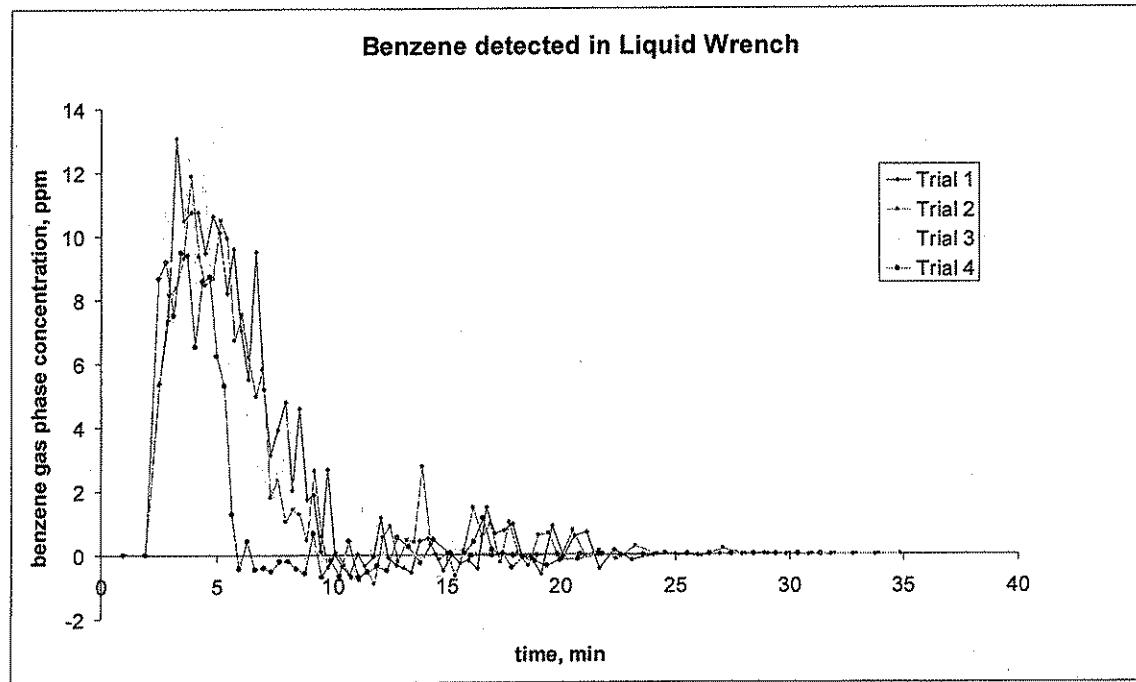


Figure 17. Gas phase benzene concentrations observed for 4 trials of evaporating Liquid Wrench.

Table 4. Benzene mass balance calculation results for the Liquid Wrench evaporation.

Trial	Mass benzene deposited (g)	Mass benzene observed (g)	% difference
1	0.870	0.494	-43.2
2	0.870	0.396	-54.5
3	0.870	0.437	-49.7
4*	0.870	0.549	-36.9

* The volumetric air flow rate through the evaporation apparatus was approximately twice that for trial 4 as it was for trials 1-3.

The decrease in mass spectrometer sensitivity toward benzene in the presence of other compounds has nothing to do with the actual evaporation rate of benzene, and if the sensitivity of the mass spectrometer to benzene is uniformly low during the entire evaporation episode, then the half life calculated from this low-sensitivity impacted data should be equal in magnitude to a half life calculated using un-impacted data. Thus the recorded benzene data is perfectly adequate for calculating the half life of benzene. Figure 18 indicate a benzene half lives of 3.0, 2.8, 2.7, and 2.0 minutes for the 4 Liquid Wrench trials, respectively, for June 6, 2009. This benzene half-life in the Liquid Wrench mixture is more than 2 times less than the half life for pure benzene calculated from the data shown in Figure 14.

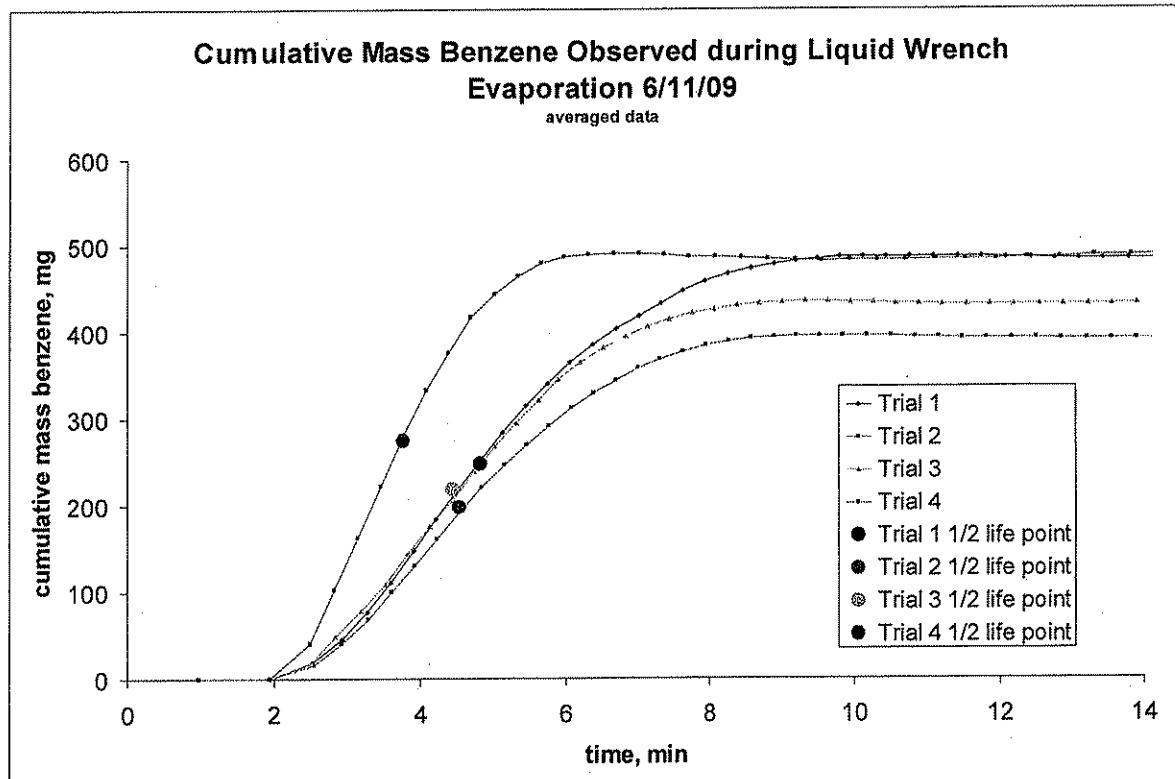


Figure 18. Cumulative benzene mass observed by the mass spectrometer during 4 trials of the evaporation of Liquid Wrench on June 11, 2009. Half-life points are indicated for each trial, and are 3.0, 2.8, 2.7, and 2.0 minutes for trials 1-4 respectively.

V-b. Liquid Wrench used on parts

In order to better simulate exposure during the use of Liquid Wrench to loosen rusted threads, four evaporation trials were performed using Liquid Wrench, 20 mL per trial, on June 12, 2009. In each trial, 20 mL of the mixture was poured, although not all at once, onto rusted bolts in the evaporation unit. The nuts and bolts were then manipulated in a manner consistent with the actions of someone using Liquid Wrench for its intended purpose. Benzene concentrations were observed by the mass spectrometer down stream of the evaporating Liquid Wrench during and after the manipulation. Figure 19 shows the gas phase benzene data for the four trials.

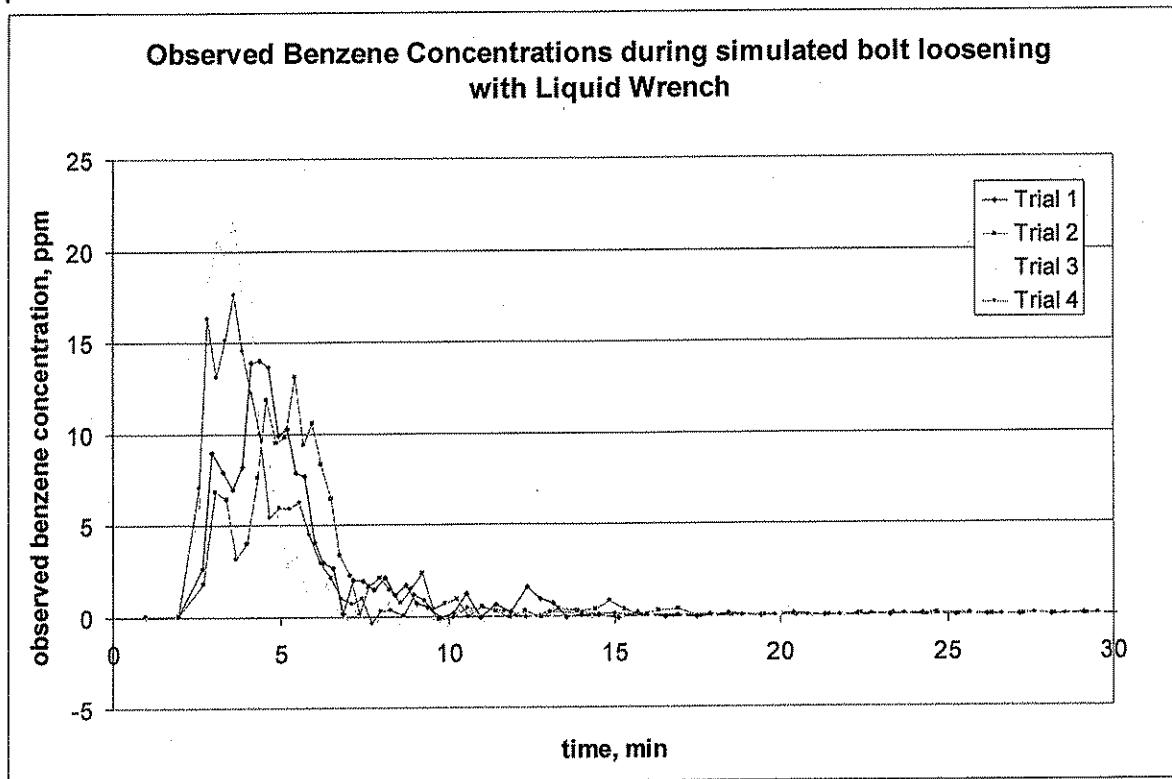


Figure 19. Observed benzene concentrations for 4 trials during simulated Liquid Wrench use to loosen bolts.

Table 5 summarizes the mass balance data for the simulated Liquid Wrench use. The results are similar to those for the evaporation of pools of Liquid Wrench.

Table 5. Benzene mass balance calculation results for the Liquid Wrench evaporation during the simulated use of Liquid Wrench to loosen rusted parts.

Trial	Mass benzene deposited (g)	Mass benzene observed (g)	% difference
1	0.870	0.379	-56.4
2	0.870	0.381	-56.2
3	0.870	0.381	-56.12
4*	0.870	0.358	-58.85

* The volumetric air flow rate through the evaporation apparatus was approximately twice that for trial 4 as it was for trials 1-3.

Likewise, data indicate the benzene half-life for the trials during which Liquid Wrench is used to loosen rusty threads is very similar to that during the evaporation of a pool of Liquid Wrench. Figure 20 shows the cumulative mass of benzene observed at the mass spectrometer for these experiments, and indicates a half-life of 2.8, 3.5, 1.8, and 1.9 minutes for trials 1-4 respectively on June 12, 2009.

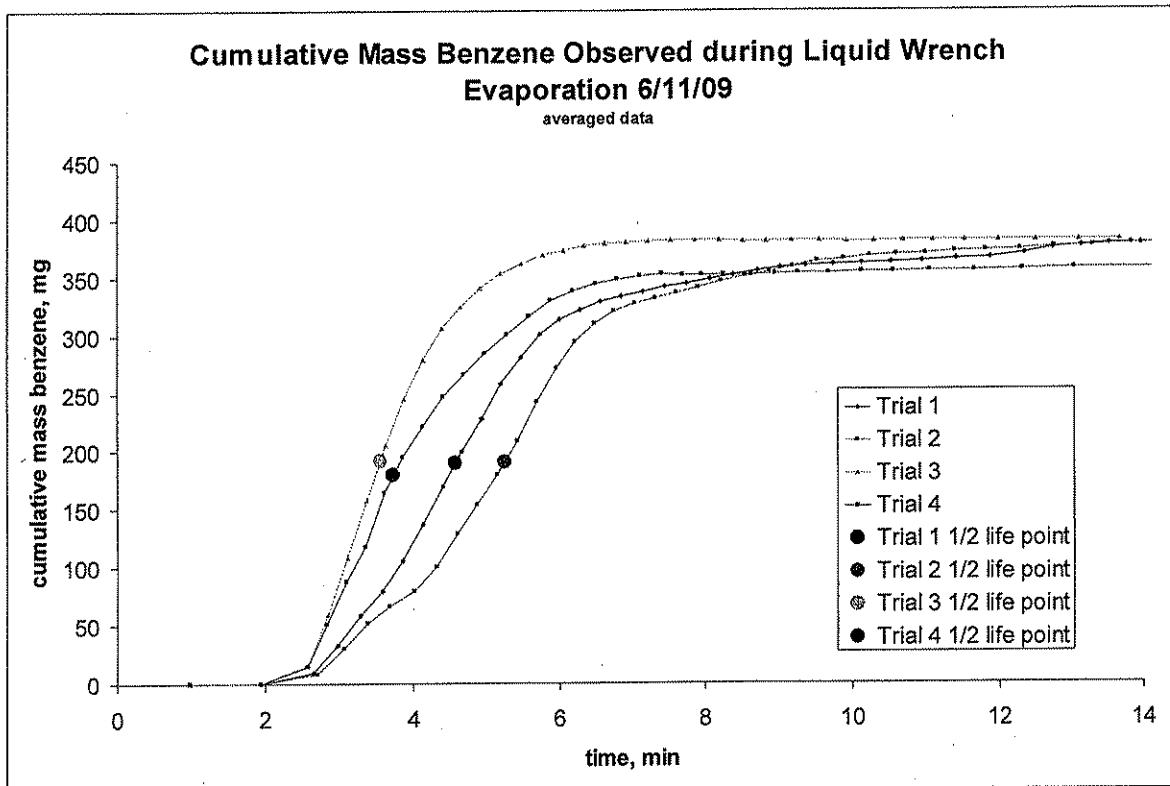


Figure 20. Cumulative benzene mass observed by the mass spectrometer during the evaporation of Liquid Wrench being used to loosen rusty threads on June 12, 2009.

VI. Conclusions

Direct sampling mass spectrometry provided adequate limits of detection for this benzene evaporation rate study while increasing the frequency with which a data point is acquired by about two orders of magnitude compared with traditional gas phase sampling methods that rely on chromatography. Provided the unit is appropriately calibrated, benzene may be measured in the gas phase down to a limit of detection of 30 ppb. Data can be obtained once a second. For pure benzene, mass balance analyses indicate that the benzene gas phase concentrations are very accurate. For benzene in a mixture of other hydrocarbons, benzene signal is suppressed, though the magnitude of that suppression was investigated and quantified, although not applied to any resulting data.

The benzene data indicate that benzene evaporation half-lives, under the conditions of this study, are about 6 minutes for 20 mL of pure benzene, and about 2.6 minutes for benzene in a Liquid Wrench mixture. These half-lives are not normalized for pool surface area or temperature.

VII. References

1. Wells, J.M.; Badman, E.R.; Cooks, R.G. *Anal. Chem.* 1998, 70, 438-444.
2. Patterson, G.E.; Guymon, A.J.; Riter, L.S.; Everly, M.; Griep-Raming, J.; Laughlin, B.C.; Ouyang, Z.; Cooks, R.G. *Anal. Chem.* 2002, 74, 6145-6153.
3. A. Keil, H. Hernandez, R. J. Noll, M. Fico, L. Gao, Z. Ouyang, R. G. Cooks, *Anal. Chem.*, 2008, 80, 734-741.

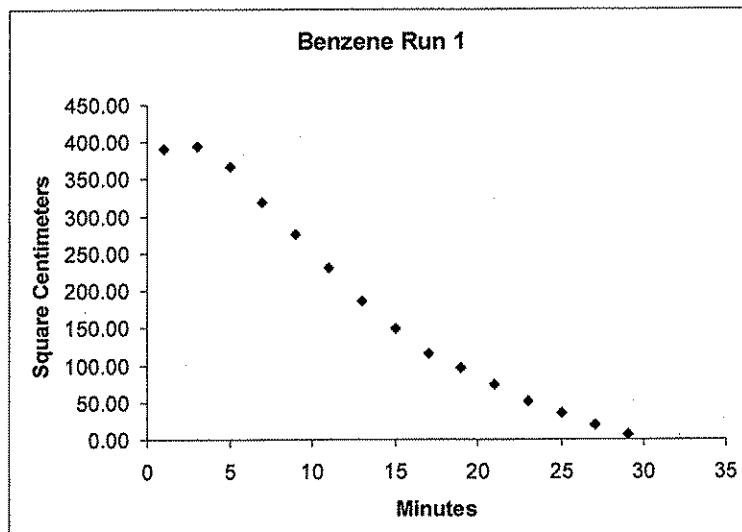
Support Document 11

Surface Area Data of Benzene Poured on Plate Glass

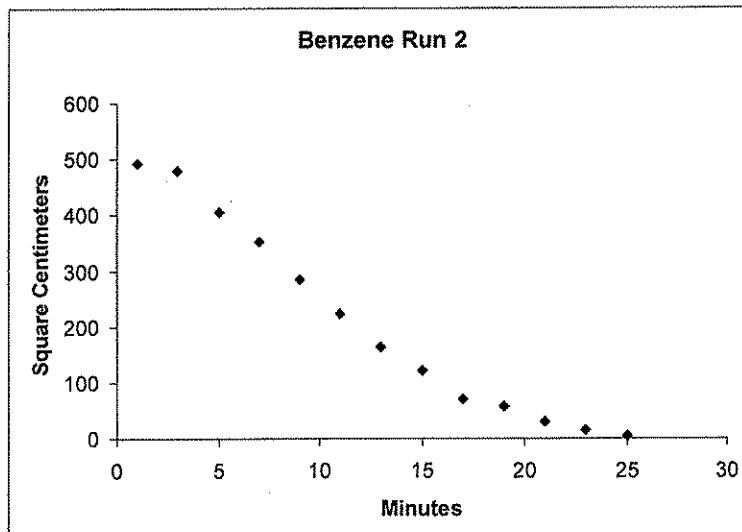
Surface Area of Benzene Poured on Plate Glass
Day 1, 6/10/2009

Benzene Run 1

<u>Elapsed Time</u>	<u>Measured Solvent Area in cm²</u>
1	390.27
3	394.68
5	366.79
7	319.32
9	275.38
11	230.94
13	186.41
15	149.42
17	116.08
19	95.88
21	73.91
23	51.80
25	35.58
27	18.85
29	6.16

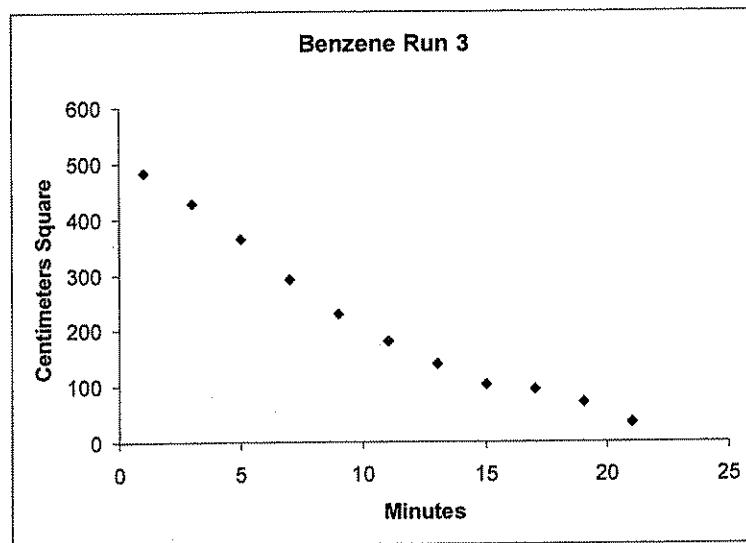
**Benzene Run 2**

<u>Elapsed Time</u>	<u>Measured Solvent Area in cm²</u>
1	491.48
3	479.53
5	405.93
7	351.43
9	284.52
11	222.25
13	164.22
15	120.42
17	70.88
19	57.44
21	30.33
23	14.87
25	4.86

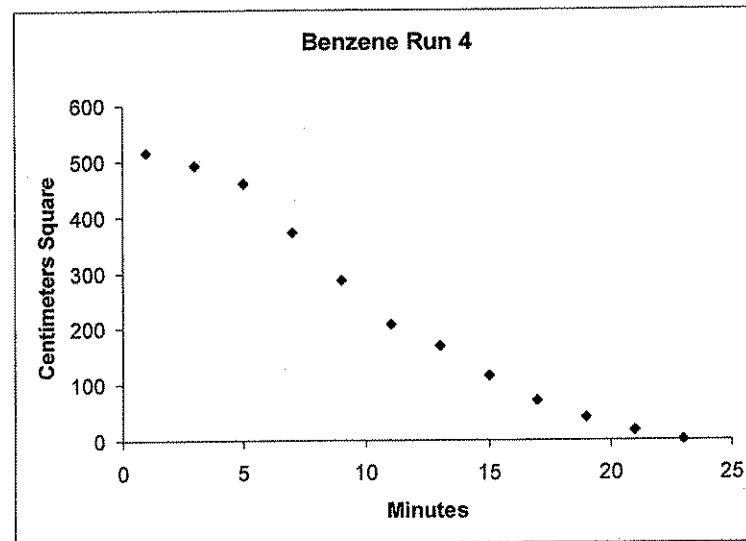


Benzene Run 3

<u>Elapsed Time</u>	<u>Measured Solvent Area in cm²</u>
1	483.03
3	427.42
5	363.10
7	289.79
9	227.77
11	179.44
13	137.74
15	103.20
17	93.58
19	70.86
21	33.40

**Benzene Run 4**

<u>Elapsed Time</u>	<u>Measured Solvent Area in cm²</u>
1	515.34
3	491.91
5	458.74
7	371.64
9	286.92
11	207.09
13	167.84
15	114.90
17	70.59
19	39.77
21	16.35
23	0.31



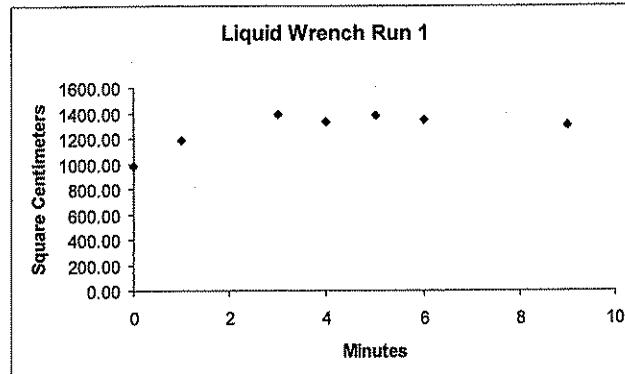
Support Document 12

Surface Area Data of Reformulated Liquid Wrench Poured on Plate Glass

Surface Area of Liquid Wrench Poured on Plate Glass
Day 2, 6/11/2009

Liquid Wrench Run 1

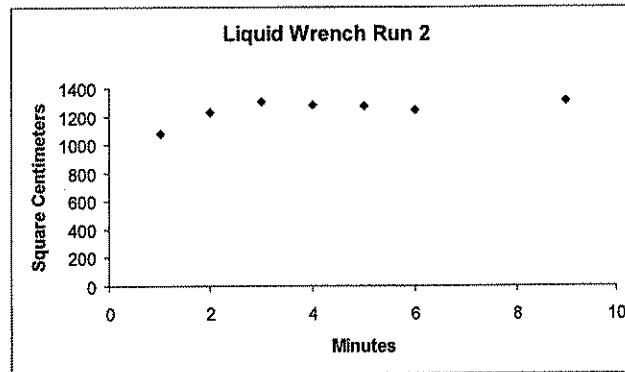
<u>Elapsed Time</u>	<u>Measured Solvent Area in cm²</u>	<u>Photo ID</u>
0	981.88	85536
1	1182.92	85619
3	1383.00	85823
4	1331.00	85920
5	1376.92	90022
6	1343.10	90120
9	1300.00	90427



6.00 percent change in pool size from maximum area to point where benzene is evaporated.

Liquid Wrench Run 2

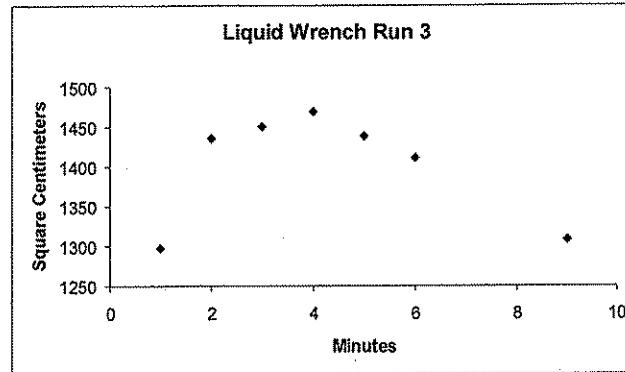
<u>Elapsed Time</u>	<u>Measured Solvent Area in cm²</u>	<u>Photo ID</u>
1	1074.53	1052
2	1226.83	1053
3	1300.66	1054
4	1281.48	1055
5	1271.00	1056
6	1241.78	1057
9	1313.00	1100



0.94 percent change in pool size from maximum area to point where benzene is evaporated.

Liquid Wrench Run 3

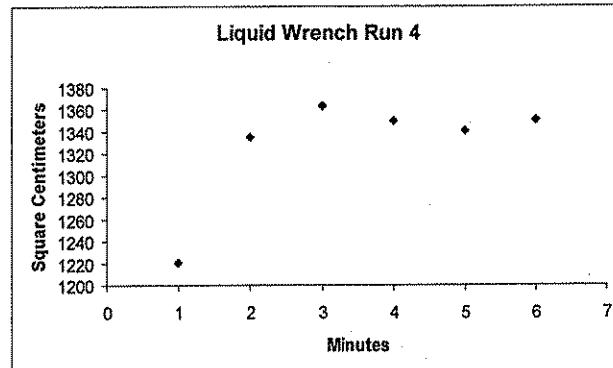
<u>Elapsed Time</u>	<u>Measured Solvent Area in cm²</u>	<u>Photo ID</u>
1	1297.28	1340
2	1435.55	1341
3	1450.37	1342
4	1468.92	1343
5	1438.43	1344
6	1411.48	1345
9	1308.00	1348



10.95 percent change in pool size from maximum area to point where benzene is evaporated.

Liquid Wrench Run 4

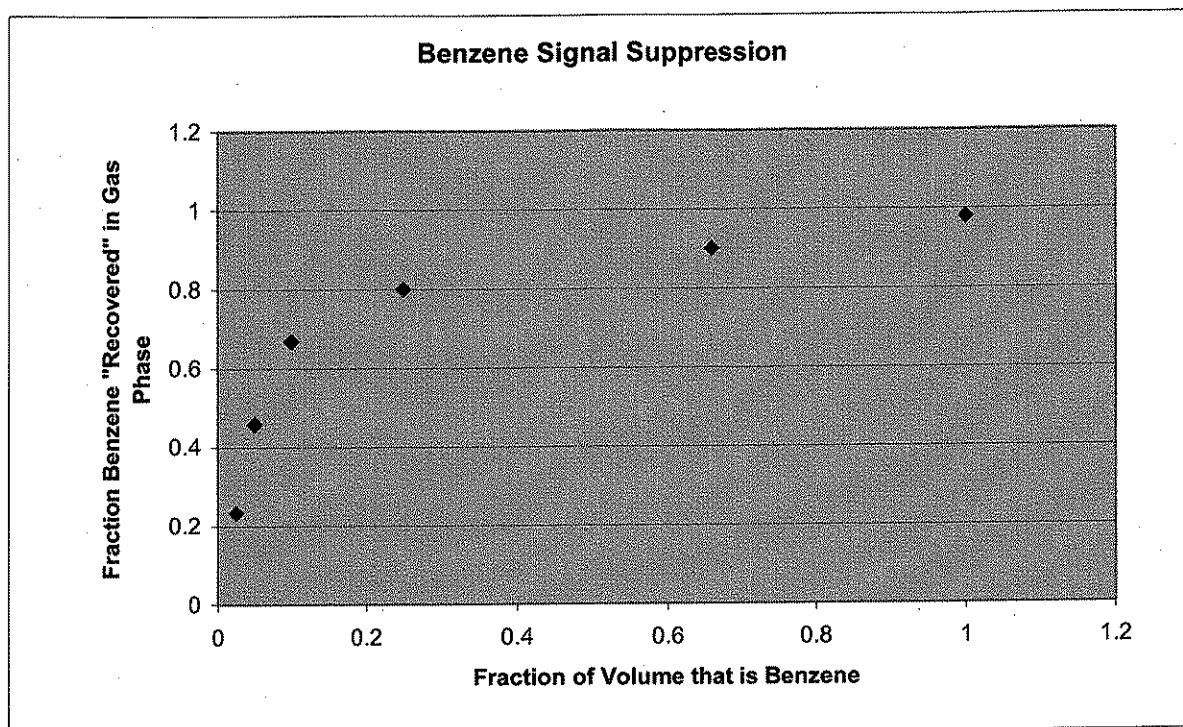
<u>Elapsed Time</u>	<u>Measured Solvent Area in cm2</u>	<u>Photo ID</u>
1	1220.61	1644
2	1334.79	1645
3	1363.05	1646
4	1350.05	1647
5	1340.9	1648
6	1350.94	1649



0.88 percent change in pool size from maximum area to point where benzene is evaporated.

Support Document 13

Chart Depicting Signal Suppression of ChemSense 600 in Mixtures of Cyclohexane and Benzene



Fraction of benzene observed in the gas phase versus the fraction of an evaporated liquid mixture that is benzene. The balance of the liquid in this case is cyclohexane. For a 5% benzene mixture, the amount of benzene measured in the gas phase, over the course of the evaporation, was 46% of the total deposited into the evaporation chamber.

Support Document 14

Field Notes



ENVIRONMENTAL PROFILES, INC.
813 Frederick Road
Baltimore, MD 21228
410-744-0700
410-744-2003 FAX

FIELD REPORT

Project No: 29125

Date: 6/10/2009

Prepared By: Dale Johnson

Day 1, Trial 1

Client:

Temperature: Pre- Post-

Project:

Relative Humidity: Post-

Evaporation Rate Study

Pre-

Location:

Barometric Pressure: Post-

EPI facility

Pre-

Columbia, MD

Liquid Temperature Start:

Glass Surface Temperature
Start:

Description of task/project:

Quantity the evaporation rate of pure benzene (20ml) poured onto a glass surface inside a glove box with air flow at 2.25fpm.

Dust Velocity Grid

Liquid Surface Temperature @ time t

	A	B	C	D	1:	6:	11:	16:
1	21	31	26	27	2:	7:	12:	17:
2	21	33	30	25	3:	8:	13:	18:
3	31	31	32	33	4:	9:	14:	19:
4	19	28	26	28	5:	10:	15:	20:

OBSERVATIONS AND COMMENTS

Time Notes

1:12 Personal pump & charcoal tube turned on.

1:22 Conducted manometer & traverse for velocity.

DAY 1- Trial 1

10 JUN 2009

1300 Direct-read instruments installed at upstream end of duct for T/RH.

1310 Air sample pump running @ 0.2 lpm for background VOC measurement.

1315 Airflow measurements being taken @ evap. chamber.

1323 Airflow measurements completed.

1325 Vial containing 20 ml benzene placed in evap. chamber.

1327 $T_{Glass} = 25.4^\circ C$

1328 $t = 0$ Liquid poured onto plate.

1329 $t = 1\text{ min}$ Summa Cannister sample taken. $T_{Liquid} = 23.4^\circ C$
 $T_{Glass} = 25.4^\circ C$

1331 $t = 3\text{ min}$ $T_{Liq} = 23.0^\circ C$
 $T_{Glass} = 25.6^\circ C$

1332 $t = 4\text{ min}$ $T_L = 22.6^\circ C$
 $T_G = 25.4^\circ C$

1333 $t = 5\text{ min}$ $T_L = 22.4^\circ C$ $T_G = 25.6^\circ C$

1334 $t = 6\text{ min}$ $T_L = 22.2^\circ C$ $T_G = 25.6^\circ C$

1335 $t = 7\text{ min}$ $T_L = 21.4^\circ C$ $T_G = 25.8^\circ C$
Summa cannister sample taken.

1336 $t = 8\text{ min}$ $T_L = 21.2^\circ C$ $T_G = 25.6^\circ C$

1337 $t = 9\text{ min}$ $T_L = 21.2^\circ C$ $T_G = 25.6^\circ C$

EPI00060

DAY 1 TRIAL #1 (continued) 6/10/09

1338

t = 10 MIN ~~T_L~~ T_L = 20.6°C T_G = 25.8°C

visually, approximately 1/2 of the liquid has evaporated.

1339

t = 11 MIN T_L = 20.2°C T_G = 25.8°C

1340

t = 12 min T_L = 19.8°C T_G = 25.6°C

1341

t = 13 min T_L = 19.4°C T_G = 25.6°C

1342

t = 14 min T_L = 19.2°C T_G = 25.6°C

1343

t = 15 min T_L = 19.0°C T_G = 25.8°C

1344

t = 16 min T_L = 18.6°C T_G = 25.6°C

1345

t = 17 min T_L = 18.4°C T_G = 25.6°C

1346

t = 18 min T_L = 18.0°C T_G = 25.8°C

1347

t = 19 MIN T_L = 18.0°C T_G = 25.8°C

1348

t = 20 MIN T_L = 17.6°C T_G = 25.8°C

1349

t = 21 MIN T_L = 17.6°C T_G = 26.0°C

1350

t = 22 MIN T_L = 17.8°C T_G = 25.8°C

1351

t = 23 MIN T_L = 18.4°C T_G = 25.6°C

1352

t = 24 MIN T_L = 17.6°C T_G = 25.6°C

1353

t = 25 min T_L = 18.2°C T_G = 25.6°C

1354

t = 26 min T_L = 18.4°C T_G = 25.8°C

1355

t = 27 min T_L = 18.8°C T_G = 25.8°C

1357 1356

t = 28 min T_L = 19.4°C T_G = 25.6°C

1358 1357

t = 29 min T_L = 19.8°C T_G = 25.6°C

1358

t = 30 min T_L = 19.8°C T_G = 25.8°C

1359

t = 31 min T_L = ND T_G = 25.6°C ~~16642~~

1400

material is visually evaporated. t = 32 min

T_L = ND T_G = 25.6°C

TIME FOR EVAPORATION = 32 min

DAY 1

6/10/2009

1403

MS unit continues data collection.

1407

SAMPLING COMPLETED. VOC SAMPLE OFF. T/RH meters off.

TRIAL # 2

1430

Air sample pump for VOC and T/RH instruments set up and running.

1440

Begin duct velocity measurements.

1445

Duct velocity measurements completed.

1450

20 ml. vial of benzene in chamber. $T_{bss} = 25.4^\circ\text{C}$.1451 $t = 0$ Pour benzene onto glass. $T_L = 24.6^\circ\text{C}$ $T_G = 26.2^\circ\text{C}$

1452

 $t = 1\text{ min}$ $T_L = 23.8^\circ\text{C}$ $T_G = 26.2^\circ\text{C}$

1453

 $t = 2\text{ min}$ $T_L = 23.4^\circ\text{C}$ $T_G = 26.2^\circ\text{C}$

1454

 $t = 3\text{ min}$ $T_L = 23.2^\circ$ $T_G = 26.2^\circ$

Summa Cannister Sample Taken

1455

 $t = 4\text{ min}$ $T_L = 22.8^\circ$ $T_G = 26.2^\circ$

1456

 $t = 5\text{ min}$ $T_L = 22.4^\circ$ $T_G = 26.2^\circ$

1457

 $t = 6\text{ min}$ $T_L = 22.0^\circ$ $T_G = 26.2^\circ$

1458

 $t = 7\text{ min}$ $T_L = 21.8^\circ$ $T_G = 26.4^\circ$

1459

 $t = 8\text{ min}$ $T_L = 21.4^\circ$ $T_G = 26.2^\circ$

1500

 $t = 9\text{ min}$ $T_L = 20.8^\circ$ $T_G = 26.2^\circ$ Summa Cannister Sample Taken

1501

 $t = 10\text{ min}$ $T_L = 20.6^\circ$ $T_G = 26.2^\circ$

1502

 $t = 11\text{ min}$ $T_L = 20.0^\circ$ $T_G = 26.4^\circ$

1503

 $t = 12\text{ min}$ $T_L = 19.6^\circ$ $T_G = 26.2^\circ$

1504

 $t = 13$ $T_L = 19.4^\circ$ $T_G = 26.2^\circ$

1505

 $t = 14$ $T_L = 19.2^\circ$ $T_G = 26.2^\circ$

DAY 1, TRIAL 2 - continued

6/10/2009

1506	$t = 15$	$T_L = 19.2^\circ C$	$T_G = 26.2^\circ C$
1507	$t = 16$	$T_L = 18.8^\circ C$	$T_G = 26.2^\circ C$
		Visually, liquid is $> \frac{1}{2}$ evaporated	
1508	$t = 17$	$T_L = 18.4^\circ C$	$T_G = 26.0^\circ C$
1509	$t = 18$	$T_L = 18.0^\circ C$	$T_G = 26.2^\circ C$ Spill has divided into 3 parts.
1510	$t = 19$	$T_L = 17.8^\circ C$	$T_G = 26.2^\circ C$
1511	$t = 20$	$T_L = 19.2^\circ$	$T_G = 26.2^\circ$
1512	$t = 21$	$T_L = 20.6^\circ$	$T_G = 26.0^\circ$
1513	$t = 22$	$T_L = 19.6^\circ$	$T_G = 26.2^\circ$
1514	$t = 23$	$T_L = 20.8^\circ$	$T_G = 26.0^\circ$ 8-9 cm ² remaining
1515	$t = 24$	$T_L = 21.0^\circ$	$T_G = 26.2^\circ$
1516	$t = 25$	$T_L = 21.0^\circ$	$T_G = 26.2^\circ$
1517	$t = 26$	$T_L = NA$	$T_G = 26.0^\circ C$ Liquid visually evaporated
1518	$t = 27$	$T_L =$	$T_G =$ MS unit continues to run,
1519	≥ 28	capturing residual vapors.	Time for evaporation = 26 minutes

1521	Measure duct velocity				
		A	B	C	D
	1	18	20	24	26
	2	17	24	29	30
	3	29	29	30	30
	4	16	19	31	30

mean = 25,125 fpm

duct measurements completed. T/RH meters off.

DAY 1 - TRIAL 3

6/10/2009

OBTAIN DUCT VELOCITY MEASUREMENTS. Sample pump; direct-read inst. on.

1608 -

	A	B	C	D	
1	25	26	29	32	29
2	23	31	31	30	28.75
3	21	24	33	16	23.5
4	28	26	29	30	28.25
					$\bar{x} = 27.125^{\circ}$

1613 -

Duct velocity measurements completed.

27.8125

54.9375

 $\bar{x} = 27.5$

1614

t = 0. Liquid poured from vial. $T_G = 25.6^{\circ}\text{C}$ $T_L = 24.8^{\circ}\text{C}$

1615

t = 1 min. $T_L = 24.0^{\circ}\text{C}$ $T_G = 26.2^{\circ}\text{C}$

1616

t = 2 min $T_L = 23.6^{\circ}$ $T_G = 26.2^{\circ}$

1617

t = 3 min $T_L = 23.2^{\circ}$ $T_G = 26.2^{\circ}$

1618

t = 4 min $T_L = 22.8^{\circ}$ $T_G = 26.2^{\circ}$

1619

t = 5 min $T_L = 22.4^{\circ}$ $T_G = 26.0^{\circ}$ Summa canister sample taken

1620

t = 6 min $T_L = 22.2^{\circ}$ $T_G = 26.2^{\circ}$

1621

t = 7 min $T_L = 21.6^{\circ}$ $T_G = 26.0^{\circ}$

1622

t = 8 min $T_L = 21.4^{\circ}$ $T_G = 26.2^{\circ}$

1623

t = 9 min $T_L = 20.8^{\circ}$ $T_G = 26.0^{\circ}$

1624

t = 10 min $T_L = 20.8^{\circ}$ $T_G = 26.2^{\circ}$

1625

t = 11 min $T_L = 20.4^{\circ}$ $T_G = 26.2^{\circ}$ Summa Cannister Sample Taken

1626

t = 12 min $T_L = 19.8^{\circ}$ $T_G = 26.2^{\circ}$ Visually, $\frac{1}{2}$ of liquid has evaporated.

1627

t = 13 min $T_L = 19.6^{\circ}$ $T_G = 26.2^{\circ}$

1628

t = 14 min $T_L = 19.2^{\circ}$ $T_G = 26.2^{\circ}$

1629

t = 15 min $T_L = 18.8^{\circ}$ $T_G = 26.2^{\circ}$

Begin 2 photos per event. Change to Canon Camera from Fuji.

DAY 1 - TRIAL 3 (continued) 6/10/2009

1630 $t = 16 \text{ min}$ $T_L = 18.8^\circ\text{C}$ $T_G = 26.2^\circ\text{C}$ 1631 $t = 17 \text{ min}$ $T_L = 18.4^\circ$ $T_G = 26.2^\circ$ 1632 $t = 18 \text{ min}$ $T_L = 18.2^\circ$ $T_G = 26.2^\circ$ 1633 $t = 19 \text{ min}$ $T_L = 18.8^\circ$ $T_G = 26.2^\circ$ 1634 $t = 20 \text{ min}$ $T_L = 18.4^\circ$ $T_G = 25.8^\circ$ 1635 $t = 21 \text{ min}$ $T_L = 18.4^\circ$ $T_G = 26.0^\circ$ 1636 $t = 22 \text{ min}$ $T_L = 21.6^\circ$ $T_G = 26.0^\circ$ 1637 $t = 23 \text{ min}$ $T_L = 21.4^\circ$ $T_G = 26.2^\circ$ Liquid has visually evaporated. $t = 23 \text{ min}$.

1638 ms unit continues to run, capturing residual vapors.

1640 Trial 3 completed.

1641 Measure Post-trial duct velocity

	A	B	C	D	
1	23	31	31	30	28.75
2	24	22	31	32	27.25
3	23	28	31	32	28.5
4	21	16	34	36	26.75

$$\bar{x} = 27.8125$$

DAY 1 - TRIAL 4

6/10/2009

(Repeat Trials 1-3, but with increased air speed)

1650

	A	B	C	D	\bar{x}
1	48	52	52	52	51
2	46	50	51	51	49.5
3	48	46	54	49	49
4	46	46	46	46	46
					$\bar{x} = 48.875$

1655

average duct velocity = 48.875 fpm

1707

Pour 20 ml benzene onto glass plate. Duct velocity = 48.875 fpm

t=0 Liquid poured from vial. $T_glass = 24.6^\circ C$ $T_b = 23.8$

1708

t=1 min $T_b = 22.8^\circ C$ $T_g = 26.0^\circ C$

1709

t=2 min $T_b = 22.4^\circ$ $T_g = 26.0^\circ$

1710

t=3 min $T_b = 22.2^\circ$ $T_g = 26.0^\circ$

1711

t=4 min $T_b = 21.6^\circ$ $T_g = 26.2^\circ$

1712

t=5 min $T_b = 21.0^\circ$ $T_g = 26.2^\circ$

1713

t=6 min $T_b = 20.4^\circ$ $T_g = 26.2^\circ$

1714

t=7 min $T_b = 20.0^\circ$ $T_g = 26.2^\circ$

1715

t=8 min $T_b = 19.6^\circ$ $T_g = 26.2^\circ$

1716

t=9 min $T_b = 19.4^\circ$ $T_g = 26.0^\circ$

1717

t=10 min $T_b = 19.2^\circ$ $T_g = 26.2^\circ$

1718

t=11 min $T_b = 18.8^\circ$ $T_g = 26.4^\circ$

1719

t=12 min $T_b = 18.2^\circ$ $T_g = 26.4^\circ$

DAY 1 - Trial #4 continued

6/10/2009

1720 $t = 13 \text{ min}$ $T_L = 18.2^\circ \text{C}$ $T_G = 26.2^\circ \text{C}$ 1721 $t = 14 \text{ min}$ $T_L = 18.0^\circ$ $T_G = 26.2^\circ$ 1722 $t = 15 \text{ min}$ $T_L = 18.6^\circ$ $T_G = 26.4^\circ$ 1723 $t = 16 \text{ min}$ $T_L = 18.4^\circ$ $T_G = 26.2^\circ$ 1724 $t = 17 \text{ min}$ $T_L = 18.4^\circ$ $T_G = 25.8^\circ$ 1725 $t = 18 \text{ min}$ $T_L = 18.6^\circ$ $T_G = 26.2^\circ$ 1726 $t = 19 \text{ min}$ $T_L = 18.8^\circ$ $T_G = 26.2^\circ$ 1727 $t = 20 \text{ min}$ $T_L = \text{ND}$ $T_G = 19.6 / 26.2$ 

where the liquid was.

1728 $t = 21 \text{ min}$ - Liquid has visually evaporated.

1732 Stopped ChemSense 600 data collector

1732 Stopped charcoal sampling at inlet for benzene.
total

DAY 2 - Trial 1

6/11/2009

Evaluate evaporation of reformulated product using first-draw reformulation.

0835 - Air on. Direct-read T/RH instruments ready.

0845 - Obtain air velocity readings from duct.

	A	B	C	D	
1	31	29	29	30	29.75
2	22	29	32	32	28.75
3	25	25	30	27	26.75
4	35	28	27	25	28.75
					$\bar{x} = 28.50$

0850 - Room air backgrounds completed w/ MS unit

0855 $t=0$. Reformulated product poured onto plate (20 ml)

$T_L = 23.4^\circ\text{C}$ $T_G = 24.0^\circ\text{C}$

0856 $t=1\text{ min}$ $T_L = 23.2^\circ$ $T_G = 23.8^\circ$

Summa canister sample collected.

0857 $t=2\text{ min}$ $T_L = 23.2^\circ$ $T_G = 23.8^\circ$

0858 $t=3\text{ min}$ $T_L = 23.2^\circ$ $T_G = 24.0^\circ$

0859 $t=4\text{ min}$ $T_L = 23.2^\circ$ $T_G = 24.2^\circ$

0900 $t=5\text{ min}$ $T_L = 23.0^\circ$ $T_G = 24.2^\circ$

0901 $t=6\text{ min}$ $T_L = 23.0^\circ$ $T_G = 24.2^\circ$

0902 $t=7\text{ min}$ $T_L = 23.0^\circ$ $T_G = 24.2^\circ$

Summa canister sample collected

0903 $t=8\text{ min}$ $T_L = 23.2^\circ$ $T_G = 24.4^\circ$

DAY 2 - TRIAL #1 (continued)

11 JUN 2009

0904	$t = 9\text{ min}$	$T_L = 23.2^\circ\text{C}$	$T_G = 24.4^\circ\text{C}$
0905	$t = 10\text{ min}$	$T_L = 23.2^\circ$	$T_G = 24.2^\circ$
0906	$t = 11\text{ min}$	$T_L = 23.2^\circ$	$T_G = 24.2^\circ$
0907	$t = 12\text{ min}$	$T_L = 23.0^\circ$	$T_G = 24.2^\circ$
0908	$t = 13\text{ min}$	$T_L = 23.0^\circ$	$T_G = 24.4^\circ$
0909	$t = 14\text{ min}$	$T_L = 23.2^\circ$	$T_G = 24.2^\circ$
0910	$t = 15\text{ min}$	$T_L = 23.2^\circ$	$T_G = 24.4^\circ$
0911	$t = 16\text{ min}$	$T_L = 23.2^\circ$	$T_G = 24.2^\circ$
0912	$t = 17\text{ min}$	$T_L = 23.2^\circ$	$T_G = 24.4^\circ$
0913	$t = 18\text{ min}$	$T_L = 23.4^\circ$	$T_G = 24.4^\circ$
0914	$t = 19\text{ min}$	$T_L = 23.2^\circ$	$T_G = 24.4^\circ$
0915	$t = 20\text{ min}$	$T_L = 23.4^\circ$	$T_G = 24.2^\circ$
0916	$t = 21\text{ min}$	$T_L = 23.4^\circ$	$T_G = 24.4^\circ$
0917	$t = 22\text{ min}$	$T_L = 23.4^\circ$	$T_G = 24.4^\circ$
0918	$t = 23\text{ min}$	$T_L = 23.4^\circ$	$T_G = 24.4^\circ$
0919	$t = 24\text{ min}$	$T_L = 23.4^\circ$	$T_G = 24.2^\circ$
0920	$t = 25\text{ min}$	$T_L = 23.6^\circ$	$T_G = 24.4^\circ$
0921	$t = 26\text{ min}$	$T_L = 23.6^\circ$	$T_G = 24.2^\circ$
0922	$t = 27\text{ min}$	$T_L = 23.6^\circ$	$T_G = 24.4^\circ$
0923	$t = 28\text{ min}$	$T_L = 23.6^\circ$	$T_G = 24.2^\circ$
0924	$t = 29\text{ min}$	$T_L = 23.6^\circ$	$T_G = 24.4^\circ$
0925	$t = 30\text{ min}$	$T_L = 23.6^\circ$	$T_G = 24.4^\circ$
0926	$t = 31\text{ min}$	$T_L = 23.6^\circ$	$T_G = 24.4^\circ$
0927	Volatile have evaporated, leaving an oil film on the glass plate.		

DAY 2- Trial# 1 (continued)

11 JUN 2009

Obtain post trial airflow measurements.

0930	A	B	C	D	\bar{x}
1	27	31	32	32	30.5
2	30	30	30	31	30.25
3	18	26	30	33	26.75
4	30	25	31	32	29.5
					$\bar{x} = 29.25$

0933 Residual oil swabbed - 20 cm² swabbed from glass plate.

0935 Trial#1 completed.

$$\text{Trial 1 mean airflow} = 28.50 + 29.25 = \boxed{28.875 \text{ fpm}}$$

DAY 2, TRIAL #2

TRIAL #2

6/11/2009

1035 Prepare for Trial #2. Vial placed in evaporation chamber.
Direct-read instruments ready, air sample pump started.

1040 Obtain air velocity measurements from duct.

	A	B	C	D	
1	20	30	26	26	25.5
2	20	22	30	31	25.75
3	22	24	28	31	26.25
4	19	16	18	22	18.75

$\bar{x} = 24 \text{ fpm}$

1050	$t=0$	$T_L = 24.2$	$T_G = 24.8$	
		Pour 20ml reformulated product onto glass plate.		
1051	$t=1$	$T_L = 23.6$	$T_G = 24.8$	
1052	$t=2$	$T_L = 23.6$	$T_G = 24.8$	
1053	$t=3$	$T_L = 23.4$	$T_G = 25.0$	Summa Cannister Collected
1054	$t=4$	$T_L = 23.6$	$T_G = 25.0$	
1055	$t=5$	$T_L = 23.4$	$T_G = 25$	
1056	$t=6$	$T_L = 23.4$	$T_G = 25$	
1057	$t=7$	$T_L = 23.4$	$T_G = 24.8$	
1058	$t=8$	$T_L = 23.6$	$T_G = 25$	
1059	$t=9$	$T_L = 23.4$	$T_G = 24.8$	Summa Cannister Collected
1100	$t=10$	$T_L = 23.4$	$T_G = 24.6$	
1101	$t=11$	$T_L = 23.4$	$T_G = 24.4$	
1102	$t=12$	$T_L = 23.4$	$T_G = 24.8$	
1103	$t=13$	$T_L = 23.4$	$T_G = 24.8$	
1104	$t=14$	$T_L = 23.4$	$T_G = 24.8$	EPI00072

Day 2, Trial #2

6/11/2009

1105	$t = 15$	$T_L = 23.4$	$T_G = 24.8$
1106	$t = 16$	$T_L = 23.4$	$T_G = 24.8$
1107	$t = 17$	$T_L = 23.4$	$T_G = 24.8$
1108	$t = 18$	$T_L = 23.4$	$T_G = 24.8$
1109	$t = 19$	$T_L = 23.4$	$T_G = 24.8$
1110	$t = 20$	$T_L = 23.4$	$T_G = 24.8$
1111	$t = 21$	$T_L = 23.4$	$T_G = 24.8$
1112	$t = 22$	$T_L = 23.4$	$T_G = 24.8$
1113	$t = 23$	$T_L = 23.4$	$T_G = 24.8$
1114	$t = 24$	$T_L = 23.4$	$T_G = 24.8$
1115	$t = 25$	$T_L = 23.4$	$T_G = 24.8$
1116	$t = 26$	$T_L = 23.4$	$T_G = 24.8$
1117	$t = 27$	$T_L = 23.4$	$T_G = 24.8$
1118	$t = 28$	$T_L = 23.4$	$T_G = 24.8$
1119	$t = 29$	$T_L = 23.4$	$T_G = 24.8$
1120	$t = 30$	$T_L = 23.4$	$T_G = 24.8$
1121	$t = 31$	$T_L = 23.4$	$T_G = 24.8$
1122	$t = 32$	$T_L = 23.4$	$T_G = 24.8$
1123	$t = 33$	$T_L = 23.4$	$T_G = 24.8$
1124	$t = 34$	$T_L = 23.4$	$T_G = 24.8$
1125	$t = 35$	$T_L = 23.4$	$T_G = 24.8$

Day 2, Trial 2 cont'd

1129 Obtain duct velocity measurements

	A	B	C	D	
1	20	15	20	23	
2	231 ^{fpm}	29	26	28	$\bar{x} = 26.14$
3	24	27	33	33	
4	32	30	30	27	
					Test average = 25.07 fpm

1135 Trial #2 completed.

DAY 2 , Trial #3

11 JUN 2009

1320

Air sample pump and direct-read T/RH units in place.

1325

Obtain airflow measurements for evap. chamber.

	A	B	C	D	
1	20	22	22	24	22
2	22	20.27	29.27	22.7	26.25
3	33	25	27	35	30
4	27	26	23	17	23.25
					$\bar{x} = 25.375$

1339

 $t=0$. 20ml reformulated product poured onto glass.

$$T_L = 24.4^\circ\text{C}, T_G = 25.2^\circ\text{C}$$

1340

$$t=1\text{ min.} \quad T_L = 24.0 \quad T_G = 25.2$$

1341

$$t=2 \quad T_L = 23.8 \quad T_G = 25.2$$

1342

$$t=3 \quad \bar{T}_L = 23.8 \quad \bar{T}_G = 25.2$$

1343

$$t=4 \quad \bar{T}_L = 23.8 \quad \bar{T}_G = 25.2$$

1344

$$t=5 \quad \bar{T}_L = 23.8 \quad \bar{T}_G = 25.2 \quad \text{summa}$$

1345

$$t=6 \quad \bar{T}_L = 23.8 \quad \bar{T}_G = 25.2$$

1346

$$t=7 \quad \bar{T}_L = 24 \quad \bar{T}_G = 25.2$$

1347

$$t=8 \quad \bar{T}_L = 23.8 \quad \bar{T}_G = 25.4$$

1348

$$t=9 \quad \bar{T}_L = 24.2 \quad \bar{T}_G = 25.4$$

1349

$$t=10 \quad \bar{T}_L = 23.8 \quad \bar{T}_G = 25.4$$

1350

$$t=11 \quad \bar{T}_L = 23.8 \quad \bar{T}_G = 25.2 \quad \text{summa}$$

1351

$$t=12 \quad \bar{T}_L = 23.6 \quad \bar{T}_G = 25.2$$

1352

$$t=13 \quad \bar{T}_L = 23.8 \quad \bar{T}_G = 25.2$$

1353

$$t=14 \quad \bar{T}_L = 23.8 \quad \bar{T}_G = 25.2$$

1354

$$t=15 \quad \bar{T}_L = 24 \quad \bar{T}_G = 25.2$$

EPI00075

DAY 2, TRIAL #3

1355	$t = 16$	$\bar{T}_L = 24.2$	$\bar{T}_G = 25.2$
1354	$t = 17$	$\bar{T}_L = 23.8$	$\bar{T}_G = 25.2$
1357	$t = 18$	$\bar{T}_L = 23.5$	$\bar{T}_G = 25.2$
1358	$t = 19$	$\bar{T}_L = 24$	$\bar{T}_G = 25$
1359	$t = 20$	$\bar{T}_L = 23.8$	$\bar{T}_G = 25$
1400	$t = 21$	$\bar{T}_L = 24.2$	$\bar{T}_G = 25$
1401	$t = 22$	$\bar{T}_L = 24.2$	$\bar{T}_G = 25.2$
1402	$t = 23$	$\bar{T}_L = 24$	$\bar{T}_G = 25.2$
1403	$t = 24$	$\bar{T}_L = 24$	$\bar{T}_G = 25$
1404	$t = 25$	$\bar{T}_L = 24$	$\bar{T}_G = 25$
1405	$t = 26$	$\bar{T}_L = 24.2$	$\bar{T}_G = 25.2$
1406	$t = 27$	$\bar{T}_L = 24.2$	$\bar{T}_G = 25.0$
1407	$t = 28$	$\bar{T}_L = 24.2$	$\bar{T}_G = 25$
1408	$t = 29$	$\bar{T}_L = 24.2$	$\bar{T}_G = 25$
1409	$t = 30$	$\bar{T}_L = 24$	$\bar{T}_G = 25.2$

1411

	A	B	C	D
1	26	20	23	26
2	27	30	29	30
3	18	30	30	31
4	31	29	29	28

$$\bar{x} = 27.3125 \text{ fpm}$$

$$\text{TRIAL 3 mean airflow} = (25.375 + 27.3125) / 2 = 26.3 \text{ fpm}$$

Day 2, Trial #4 High Velocity 11 June 2009

1437 Air sample pump & direct read T/RH units in place

1438 Obtain airflow measurements for each member

	A	B	C	D
1	50	57	47	49
2	50	55	52	50
3	58	57	54	58
4	49	47	52	52

$$\bar{x} = 51.9375 \text{ fpm}$$

1443 $t=0$ 20 mL reformulated product poured onto glass

$$T_L = 24.4 \quad T_G = 25.4$$

1444 $t=1 \text{ min}$ $T_L = 24.4$ $T_G = 25.4$

1445 $t=2$ $T_L = 24.4$ $T_G = 25.4$

1446 $t=3$ $T_L = 24.2$ $T_G = 25.4$

1447 $t=4$ $T_L = 24.4$ $T_G = 25.4$

1448 $t=5$ $T_L = 24.4$ $T_G = 25.4$

1449 $t=6$ $T_L = 24.4$ $T_G = 25.4$

1450 $t=7$ $T_L = 24.4$ $T_G = 25.4$

1451 $t=8$ $T_L = 24.4$ $T_G = 25.4$

1452 $t=9$ $T_L = 24.4$ $T_G = 25.4$

1453 $t=10$ $T_L = 24.4$ $T_G = 25.4$

1454 $t=11$ $T_L = 24.4$ $T_G = 25.4$

1455 $t=12$ $T_L = 24.4$ $T_G = 25.4$

1456 $t=13$ $T_L = 24.4$ $T_G = 25.4$

1457 $t=14$ $T_L = 24.4$ $T_G = 25.4$

1458 $t=15$ $T_L = 24.4$ $T_G = 25.4$

1659	$t = 16$	$T_L = 24.4$	$T_G = 28.4$
1700	$t = 17$	$T_L = 24.4$	$T_G = 25.4$
1701	$t = 18$	$T_L = 24.4$	$T_G = 25.6$
1702	$t = 19$	$T_L = 24.4$	$T_G = 25.4$
1703	Trial completed		

244

Solvent Evaporation Study

Day 3 12 Jun 2009

TRIAL 1

0930 Direct-read T/PH instruments ready.

0935 Flanges, tools, and reformulated product placed in evap. chamber.

0940 Photographs taken of evap. chamber. Low-Flo pump started for VOC sampling.

0945 Take duct velocity measurements @ evap. chamber.

	A	B	C	D	
1	22	22	27	26	
2	31	28	30	30	$\bar{x} = 27.0625 \text{ fpm}$
3	26	30	32	32	
4	18	25	27	27	

0950 Hold

10:02 Lid of CW removed and liquid poured on four nuts; then work piece turned over and the other four bolts were wetted with solvent. The nuts were tapped with wrenches.

10:04 Second work piece four bolts were wetted with liquid and tapped. Then work piece turned over and the other four bolts were wetted with liquid. The bolts were then tapped.

10:05 All liquid dispensed, more tapping of bolts.

10:06 Scamma can grab sample taken

10:06 Bolts loosened with wrenches

24.8°C Glass

23.6°C Flange surface

10:08 Bolts removed on work piece one with fingers

10:40 Using wrenches, loosening bolts on work piece #2. (4 min) since all liquid dispensed

EP100079

DAY 3, TRIAL #1

6/12/2009

10:11	(5 min)			
10:12	Loosening bolts with fingers			
10:13	Removing (7 min) all bolts removed			
10:13	moving pieces on glass, checking pieces			
10:14	the small amount of liquid on gloves - covering the palms & fingers on the front, very little on the back of fingers			
10:15	removed ^{hands} gloves from gloves - flopped ^{left} glove around			
10:16	Completed tasks			
10:17 - 10:19	Waiting for Adam to clear			
10:20	Mark shook the gloves around; vial has minuscule amt. of material in it believed to be oil			
10:22	most invisible pooling has evaporated & according to mass spec, still some residual, so will allow it to run for about another 5 minutes. - residual looks like toluene & ethyl benzene			
10:40	Mass spec readings completed. Obtain airflow measurements.			
	A B C D			
1	30	24	23	24
2	22	26	30	30
3	28	25	35	33
4	29	26	19	9
				$\bar{x} = 25.8125$
10:45	Trial #1 completed.	$\text{Mean airflow} = (27.0625 + 25.8125) / 2$ $= 26.44 \text{ fpm}$		

DAY 3, TRIAL # 2

6/12/2009

1105 Direct-read T/RH instruments set-up. Lo-flow pump running. All materials placed inside of evap chamber.

1106 Measure air velocity in evap chamber.

	A	B	C	D	
1	28	28	30	19	
2	30	24	28	30	$\bar{x} = 27.75 \text{ fpm}$
3	33	32	35	32	
4	30	25	21	19	

1107 Opening Liquid wrench bottle, dispensing liquid on four bolts workpiece one, followed by application of liquid on four bolts workpiece two.

Bolts on work pieces were torqued repeatedly.

~~1108~~ 1107 Work pieces turned over and liquid applied to bolts on both work pieces. Bolts on work pieces torqued repeatedly.

1108 Additional liquid poured onto bolts, both work pieces. Work pieces turned over and a 2nd application applied to bolts, both pieces.

1109 Bolts on work piece torqued repeatedly

1110 Loosening bolts (1 min) on work piece one with wrenches.

1111 Removing bolts with fingers, work piece one (2 min)

1112 Loosening bolts on work piece two with wrenches

1113 Removing bolts with fingers, work piece ~~two~~ ^{one}

1114 Summarize (3 min), completed removal of bolts workpiece one

1115 23.8 °F Flange

25.2 °F Glass

1116 Loosening bolts workpiece two with wrenches

EPI00081

1124 (5 min) Loosening bolts with wrenches, work procedures

1125 6 min " " " " " "

1126 2 min " " " " " "

1127 Removing bolts with fingers

1127 Back to using wrenches on bolts. (8 min)

1128 Intermittent use of fingers and wrenches to loosen bolts

1128 (2 min) Summa grab

1128 Removing bolts with fingers and with wrenches.

1129 Bolts all removed, parts separated

1129 (10 min)

1130 palms and front side of fingers contain liquid

1131 (11 min)

1131 Shake gloves

1133 Removed hairs from gloves
static environment

11:54 ChemSense stopped tracking / recording

11:54 Charcoal tube stopped at inlet.

31	32	28	22	1
31	31	27	36	2
34	34	33	27	3
29	31	32	16	4

D C B A

DAY 3, TRIAL #3

6/12/2009

1315

Obtain airflow measurements from duct -

	A	B	C	D	
1	31	32	31	29	
2	28	25	30	31	
3	31	32	32	31	$\bar{x} = 28.6875$
4	26	21	23	26	

1320

direct read T/RH instruments set up. Ho-flo pump operating. All tools & materials inside of evap. chamber.

1:28

Opening liquid wrench, pouring on bolts on top left & right side. Then rotated piece to wet the other bolts on the lower side.

1:29

Topping bolts on bottom side, rotate piece, top bolts on top.

1:30

Dispensed the last part of liquid on top bolts. Slight pooling of liquid under each

1:31

Using wrenches to loosen bolts on top of work piece. flange.

1:31

(1 min) Rotated work piece, used wrench to loosen bolts, check bolt loose by removing with fingers.

1:32

(2 min) Removing top bolts using fingers

1:33

Right side flange removed

1:33

(3 min) Loosening bolts using wrenches

1:34 (4 min)

removing bolts with fingers (5 min) Summary com

1:36

Loosening bolts ~~with~~ with wrench & loosening bolts w/ fingers

1:37

(6 min) "

1:37 Removing bolts with fingers

1:38 Using wrench on last bolt.

1:39 (8 min)

EPI00083

1:39 Removing last bolt with fingers (9 min)

1:40 Drying parts, inventing & placement. (10 min)

1:41 24.6 °C Flange

25.4 °C Glass

1:42 Work completed.

1:42 (11 min) Samra cannister grab

1:42 Shaking gloves in 15 seconds

1:43 (2 min)

1:43 Static environment (no activity)

13:59 MS unit stopped.

14:10 Measure air velocity in duct

	A	B	C	D	
1	30	26	29	32	
2	19	24	31	33	$\bar{x} = 25.75$
3	15	25	33	16	
4	28	26	22	23	

14:15 Trial 3 completed. Mean airspeed = $(28.6875 + 25.75) / 2 = 27.22 \text{ fpm}$

Day 3, Trial 4

Obtain air flow measurements from duct

0242

1	29	32	33	15
2	27	30	31	25
3	28	31	35	32
4	14	21	21	18

A B C D

0243

Gloves 25.6 °C - Stopwatch started when cap ~~seat~~ removed

0244

Pouring small amount of liquid onto palm of left ~~left~~ hand.

He then wiped his hands together. Repeated same procedure.

0245

(2 min) 1/2 of liquid dispersed on hands.

0247

Applied more to gloves, some liquid pooled on glass - all liquid dispersed

0248

(2 min) (tools are hard to hold with liquid on hands. (note: hands mean gloves)

0249

(4 min)

0250

(5 min) air drying gloves - shaking gloves

0252

(7 min) holding gloves steady

8 min

" " "

0255

Hands removed from gloves, gloves resting in chamber.

1	28	30	31	32
2	26	27	30	32
3	23	23	27	31
4	15	31	28	28

A B C D

Day 4 - Trial 1

15 JUN 2009

1345
~~1339~~Direct-read instruments installed at upstream
end of duct for T/RH

1351

Air flow measurement setup taken @
avg chamber

1	28	30	29	27
2	23	29	31	30
3	27	28	32	30
4	20	20	18	19

A B C D

1353

Poured L.W.

GL

1353

23.6

22.8

1355

23.4

22.6

1357

23.8

22.6

1359

23.6

22.6

1401

23.8

22.6

1403

24.0

22.8

1405

24.0

22.8

1407

24.0

22.8

1409

24.0

22.8

1411

24.0

22.8

1413

23.8

22.8

1415

23.8

23.0

1417

24.0

23.2

1419

24.0

23.0

15 June 2009

GL

1421

24.0

23.2

1424

23.2

24.2

(Heather did ¹⁰ reading)~~1425~~

Not collected

1427

23.4

24.4

1429

Stopped @ 1428 - 35 minutes

1431

1433

Solvent Evaporation Study Air Velocity Measurements

23.8

Measured Air Velocities (ft/min.)

	Day 1	Day 2	Day 3
Trial 1	27.63	28.88	26.44
Trial 2	26.06	25.07	
Trial 3	27.50	26.34	
Trial 4	48.88	51.94	

26,4

247

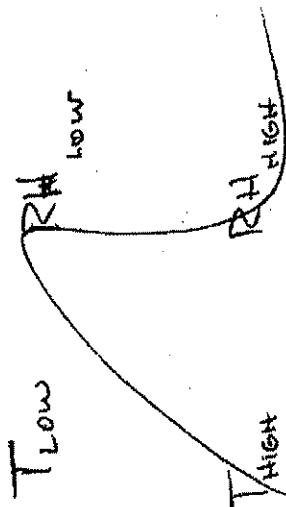
$$\text{stddev} = 1.25$$

26

Benzene
Average evap times

264

	<u>Day 1</u>	<u>Day 2</u>	<u>Day 3</u>			
Trial 1	32 10	31. 5	16 $4\frac{1}{2}$			
Trial 2	26. 8	35. 5	15 $5\frac{1}{2}$			
Trial 3	26. 8	30 $4\frac{1}{2}$	14 $4\frac{1}{2}$ $3\frac{1}{2}$			
Trial 4	20 6	19 $3\frac{1}{2}$	14 $3\frac{1}{2}$	$ \begin{array}{r} 26 \\ 25.2 \\ 25.5 \\ \hline 76.7 \end{array} $		
\bar{S}	27.06	26.76	27.45			
\bar{t}	$ \begin{array}{r} 25.8 \\ 26.0 \\ 26.0 \quad 26^{\circ}C \\ 25.9 \quad 46.5\% \end{array} $	$ \begin{array}{r} 24.7 \\ 25 \\ 25.4 \\ \hline 25.7 \end{array} $	$ \begin{array}{r} 48.7 \\ 47 \\ 46.2 \\ \hline 46.1 \end{array} $	$ \begin{array}{r} 25.1 \\ 25.4 \\ 25.7 \\ \hline 25.9 \end{array} $	$ \begin{array}{r} 44.7 \\ 45.3 \\ 44.3 \\ \hline 44.1 \end{array} $	$ \begin{array}{r} 396 \\ 9 \end{array} $
					EPI100088	

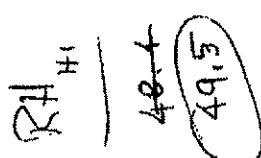


$$0.05 \times 20 = 100$$

5

$$\frac{4.0 \text{ ml}}{0.88 \text{ / ml}} = \frac{880 \text{ ml}}{880 \text{ ml}}$$

$$\frac{7.1}{880} = 0.81\%$$
$$\frac{6.1}{880} = 0.69\%$$
$$\frac{5.6}{880} = 0.64\%$$



	Day 1 Room	Day 1 Glass		Day 2 Room	Day 2 Glass		Day 3 Room	Day 3 Glass
Trial 1	25.8	25.7		24.7	24.4		25.1	24.8
Trial 2	26	26.2		25	24.8		25.4	25.2
Trial 3	26	26.2		25.4	25.2		25.7	25.4
Trial 4	25.9	26.2		25.7	25.6		25.9	25.6